

# Current Science



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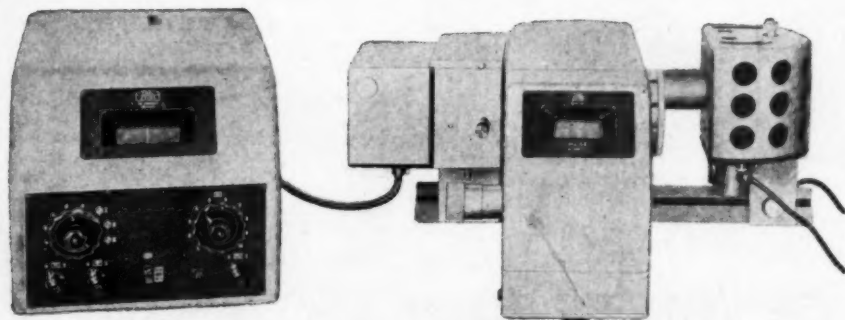
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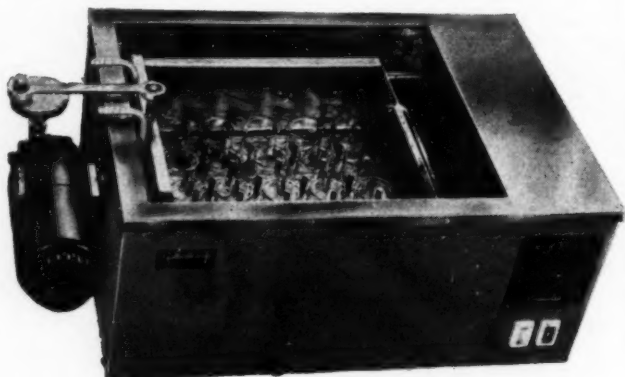
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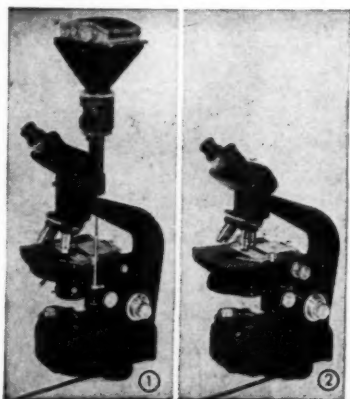
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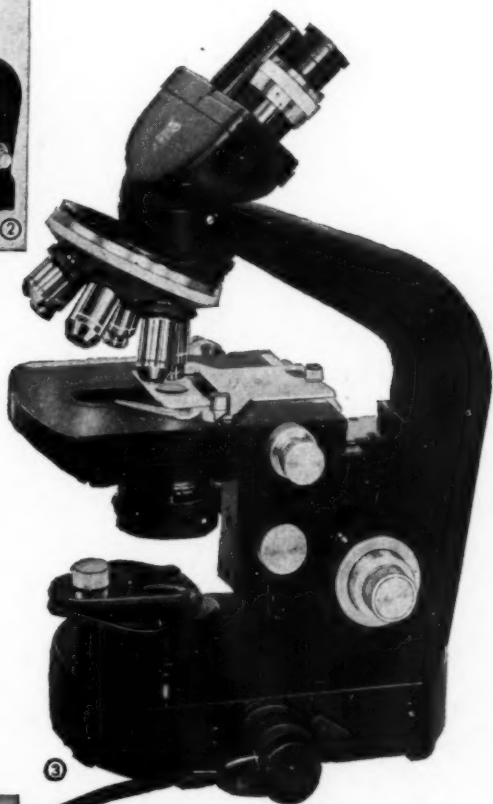


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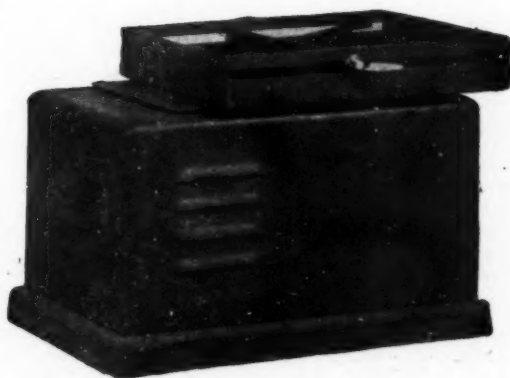


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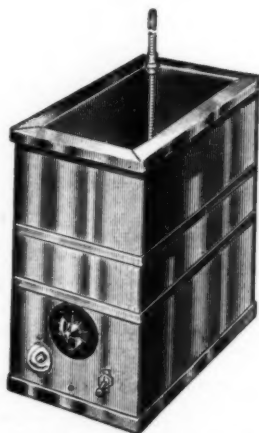
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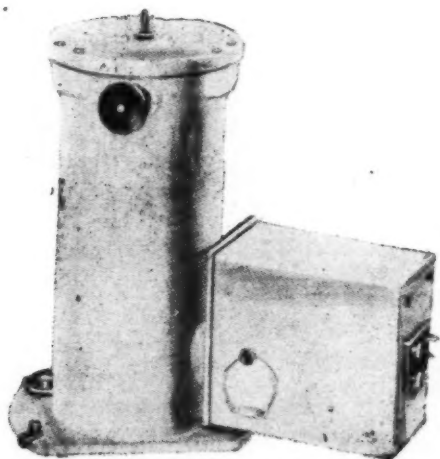
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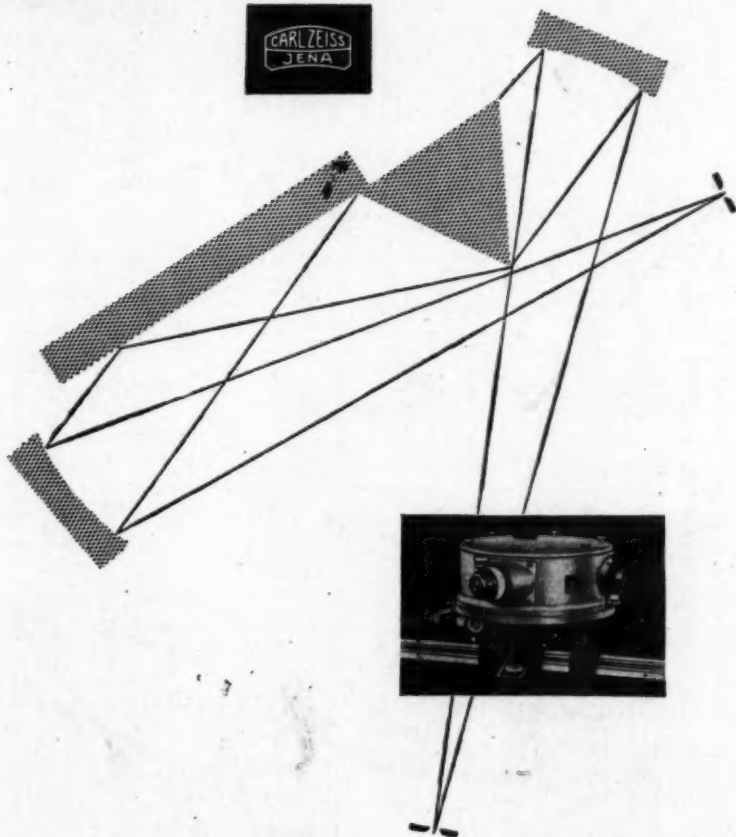
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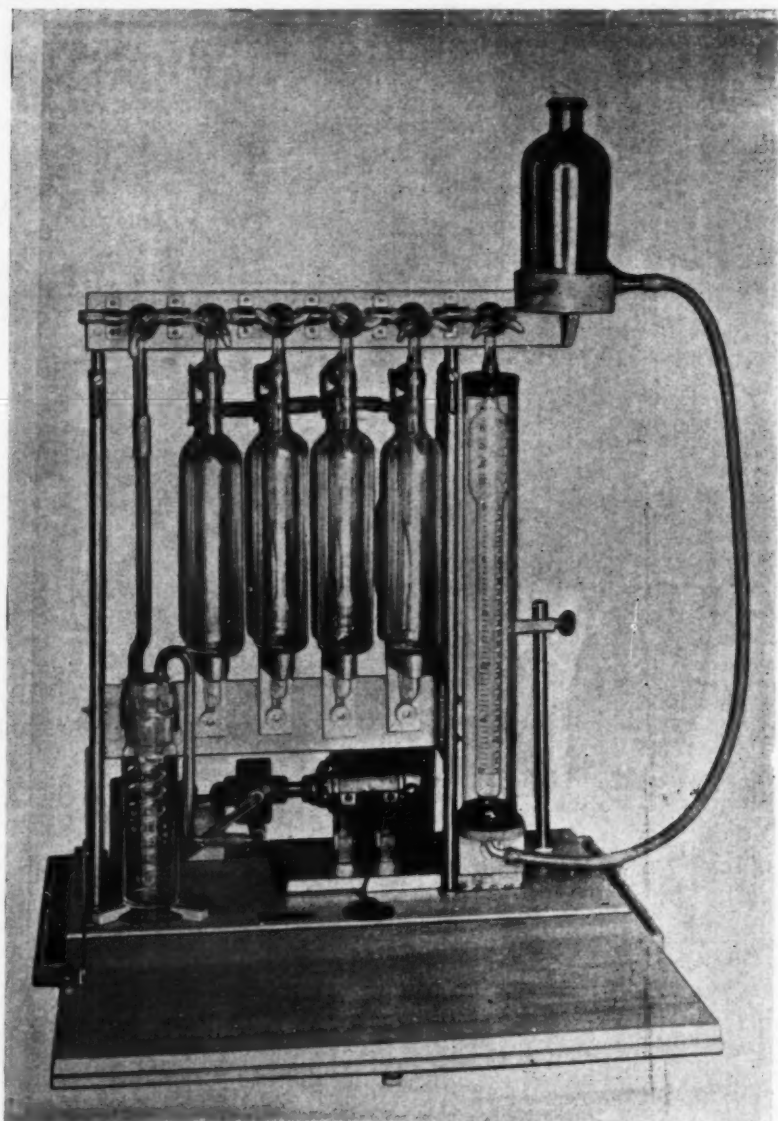
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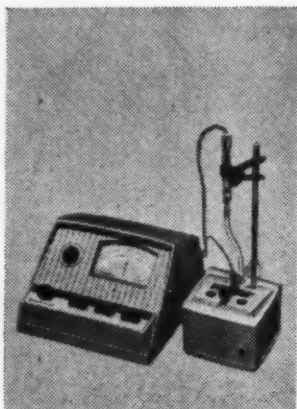
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# COHERENCE PROPERTIES OF ELECTROMAGNETIC RADIATION\*

## PART I

S. PANCHARATNAM

### 1. INTRODUCTION

**T**HOMAS YOUNG in his classic experiment of 1807 showed that the light diverging from two adjacent slits, illuminated suitably from behind, gives rise to dark and bright fringes on a screen placed in front of the slits. Given that light is a wave-phenomenon, this consequence follows naturally. The apparent mystery is that light beams do not always exhibit the phenomenon of interference. Interference fringes are not formed when the two slits are illuminated by two independent laboratory sources of monochromatic light—the light disturbances at the two slits being then said to be mutually incoherent. On the other hand, if the two slits are illuminated by a single point source, interference effects of maximum visibility are produced—the disturbances at the slits being then described as completely coherent with one another.

Suppose a second point source be kept adjacent to the first at such a distance that the double slit interference pattern due to this illuminating source alone is shifted by half a fringe-width relative to that due to the first source alone. As a net result no interference fringes would be visible on the screen, so that the disturbances at the two slits—regarded as secondary sources—must again be described as mutually incoherent. For a smaller separation of the two point sources the fringes reappear though with diminished visibility—the minima not being absolutely dark. The disturbances at the two slits could then only be described as *partially* coherent with one another. It would be natural to take the visibility of the fringes (as defined by Michelson) as a measure of the mutual degree of coherence  $\gamma$ , the displacement of the fringe system from its standard position determining the effective phase difference  $\delta$ . It turns out that two partially coherent disturbances could also be pictured in the following manner: An independent fraction  $\gamma^2$  of the intensity of one disturbance could be regarded as completely coherent with the second and having a phase advance  $\delta$  over it—the remaining fraction being incoherent with the second disturbance.

The phenomena depending on the interference of light (using sensibly monochromatic light and usual conditions of path retardation) merely show that for a duration long compared with the period of the light wave, the vibration cannot depart sensibly from an ideal periodic vibration having a specific amplitude and absolute phase. However, because of the extremely short period of the light wave, we may yet suppose that the temporary intensity and absolute phase fluctuate millions of times a second—the optical characteristics of a beam as observed in usual experiments depending only on certain average quantities. The fluctuations of the temporary intensity and phase occurring in two *coherent* disturbances would be absolutely correlated with one another—such disturbances usually originating from the same point source or atom. In a monochromatic source of light we could crudely picture each atom as radiating a succession of wave-trains. If the phases of the successive wave-trains are assumed to change in a random manner, the radiation reaching a point from two different atoms will sometimes interfere constructively, and at other times destructively—the net result being no overall interference, the average intensity being merely the sum of the average intensities of the disturbances due to each source separately. The average length of each wave-train and its duration of emission may be called the 'coherence length' and the 'coherence time' respectively. It is to be expected that if the radiation from a point source is split into two beams, one of which is allowed to suffer a very large path retardation relative to the other—larger than the coherence length—then the beams would become effectively incoherent, as displayed by the lowering of the visibility of interference fringes. Such an effect is indeed observed and we shall return to this point later. However, under normal conditions of the path retardation, two disturbances originating from the same monochromatic point source may be regarded as completely coherent.

More generally, by introducing the concepts used in the mathematical analysis of noise—such as the correlation function between two statistically fluctuating quantities—the mutual degree of coherence between two disturbances can be defined without any detailed assumption regarding the nature of the light disturbances

\* This was the title of a Conference held at Rochester, N.Y., from the 27-29 June 1960. The present article introduces some of the topics presented there, but is not meant to be a report of the proceedings.



emitted by individual atoms. Such an analysis has been developed in detail by E. Wolf<sup>1</sup> who, appropriately, reviewed the field at the Conference. If we assume that the light disturbance at a time  $t$  can be expressed uniquely as the real part of a complex variable  $V(t)$ , then Wolf introduces the mutual coherence function  $I_{12}(\tau) = \langle V(t)V^*(t+\tau) \rangle$ . The sharp brackets denote time average and the mutual coherence function  $I_{12}(\tau)$  expresses the correlation between two disturbances 1 and 2, the first disturbance being considered at a time  $\tau$  later than the second. For sensibly monochromatic radiation and for usual experiments where the path retardations involved are small compared with the coherence length, the mutual coherence function relating two disturbances may be considered a constant independent of  $\tau$ .

## 2. COHERENCE AND MONOCHROMATICITY

There is another point of view from which the phenomenon of partial coherence may be analysed. We have already mentioned that when two beams—obtained by the splitting of a single collimated beam—are allowed to interfere, the visibility of the interference effects goes down when the relative path retardation introduced is made very large, i.e., comparable with the coherence length for the monochromatic radiation used. As is well known, this experiment was performed by Michelson who however used the variation in the visibility of fringes to determine the shape of the spectral 'line' emitted by the source. It thus becomes clear that the phenomenon of incoherence and partial coherence stands in the most intimate connection with the lack of strict monochromaticity.

The finite spectral width of all radiation that can be used or detected must be recognised as inevitable and intrinsic in the nature of things, so that only properties of radiation averaged over a small spectral range can be regarded as physically measurable quantities. A strictly monochromatic wave-train would be one whose amplitude and phase are constant in time and hence would extend from *plus* infinity to *minus* infinity. If the wave-train from atoms were of this nature, the radiations from different atoms could interfere and the phenomenon of incoherence would not exist. A disturbance consisting, for example, of a succession of wave-trains whose amplitudes and phase factors vary in time is therefore *not* strictly monochromatic but quasi-monochromatic. By Fourier's theorem, such a disturbance could be regarded as the sum of a number of strictly monochromatic

vibrations spread over a small but finite spectral range of frequencies, the amplitude and phase factor of each monochromatic component being naturally constant quantities and not fluctuating in time. The average intensity of the quasi-monochromatic beam which alone is measurable is the sum of the 'intensities' of its monochromatic constituents.

Considering now the case of two interfering beams which are quasi-monochromatic, the strictly monochromatic component of a particular frequency in one of the beams will necessarily be completely coherent with the corresponding component of the same frequency in the second beam. In the case of two *coherent* beams the phase difference  $\delta_m$  between a corresponding pair of monochromatic constituents of the same frequency  $\nu_m$  in the two beams will be the same as the phase difference  $\delta_m$  between the interfering pair of frequency  $\nu_m$ . At the other extreme for *incoherent* beams, the phase differences  $\delta_m, \delta_n$ , etc., between corresponding pairs of monochromatic constituents will be distributed from zero to  $2\pi$ —so that the average intensity of the resultant quasi-monochromatic beam obtained by their superposition is merely the sum of the average intensities of the original beams. For intermediate cases, the degree of coherence and effective phase difference between two quasi-monochromatic beams or disturbances could be defined in a manner closely analogous to the conventional method—except that in the present view-point an averaging over frequency rather than time is involved in the definitions. This analysis was included in the paper presented by Pancharatnam,<sup>2</sup> which dealt with two beam interference taking into account the fact that the beams may be polarised, completely or partially—a factor which we have not till now referred to.

## 3. CORRELATION OF PHOTONS IN COHERENT BEAMS

The basic picture of interference given by the quantum theory is often discussed in theoretical text-books with reference to an imaginary two-beam interference experiment with weak light. A sufficiently accurate experiment of this nature was, however, only recently performed by Janossy<sup>3</sup> and co-workers in Hungary. They used a Michelson interferometer of very large dimensions in which, as is well known, a semi-silvered mirror is used to split an incident collimated beam into two coherent beams which travel along the arms of the interferometer and are then allowed to interfere. Light of such low intensity was used that on the average there would be only one



photon, at any instant somewhere in the arms of the interferometer. First an experiment was performed which, it should be noted, automatically prevents the beams from interfering: two photo-tubes were placed respectively in the paths of the two beams and connected to a coincidence counter. The absence of significant coincidences verifies that a single photon on striking the semi-silvered plate does not of course split, but is either reflected or transmitted with equal probability. However, according to quantum theory when the interference experiment is performed, the state function for the photon, governing the probability of its appearance somewhere in the field of interference, is now a coherent superposition of the state functions involving both beams. In accordance with this it was found on taking a very large number of counts in the field of interference that no photons fell in certain regions—'dark fringes'—and the maximum number fell in adjacent 'bright fringes'.

Considerable discussion arose in the columns of *Nature* when Twiss and Brown showed definitely that the coherence or otherwise of two beams could be detected even without allowing them to interfere, just by seeing whether the intensity fluctuations in the two beams were correlated. These discussions having already cleared the air, there was not much additional discussion of a basic nature at the Conference when they presented their work. In the first type of experiment performed by them,<sup>4</sup> a semi-silvered mirror was used to split the radiation from a source into two beams which were received on two separate photo-tubes with small apertures. The fluctuations occurring in the output of the two photo-multipliers were found to be correlated when the disturbances received at the tubes were expected to be coherent, and uncorrelated under conditions when they were expected to be incoherent. Classically it is immediately obvious that if there is a fluctuation of intensity above average in a wave-train falling on a semi-silvered mirror, the fluctuations will continue in the two wave-trains into which it is split. It must be noted that the intensity fluctuation mentioned is intrinsic in the nature of things and not due to macroscopic fluctuations in the conditions of operation of the source; indeed, Brown and Twiss proved that this was not the factor causing the correlation. In the wave-picture the fluctuations arise from the fact that Fourier components of different frequencies (contained within the finite spectral width) interfere with one another giving rise to beats or fluctuations of intensity about its

average value. Clearly the intensity fluctuations in radiation from independent sources could not be expected to have any correlation.

In a second experiment which more closely illustrated the particle aspect of light,<sup>5</sup> two coherent monochromatic beams of light (from a mercury isotope lamp) were as before received on two photo-tubes; these were connected to a coincidence counter to record the occasions when the times of arrival of two light quanta at the two respective photo-tubes lay within the resolving time of the coincidence counter. Brown and Twiss demonstrated that when the beams were coherent the number of 'coincidences' were in excess of the random value. Considering the picture of a collimated light beam as a hail of quanta, the average intensity will be given by the number of photons received per second, but even with the steadiest source obtainable there are bound to be fluctuations from this average rate, which may be determined by statistics; in fact, since photons obey Bose-statistics and not classical statistics, there is a tendency for photons to 'clump', i.e., the fluctuation in the rate will be slightly greater than for a random sequence of independent events occurring at the same average rate. This additional fluctuation in a single beam may in turn be considered as giving rise to the Brown-Twiss effect mentioned, viz., that the 'coincidences' between photons received in two coherent beams exceed the random value. If the photons had obeyed classical statistics there would be no correlation between photons in two coherent beams. It was shown by Purcell,<sup>6</sup> as also by Brown and Twiss that these observations did not really conflict with those of Janossy *et al.*, since the latter's arrangement would be far too insensitive to detect this correlation.

#### 4. LIGHT BEAMS FROM INCOHERENT SOURCES

According to classical ideas, two waves of different frequency can interfere with one another giving rise to beats or a periodic fluctuation of intensity at a frequency equal to the difference in the frequency of the two superposed disturbances. Forrester reported on an experiment in which the beats had been detected by mixing the Zeeman components of a visible spectral line at a photo-surface. The periodicity in the emission current was detected by the excitation of a 3 cm. microwave cavity tuned to the beat frequency—a special photo-mixer tube being designed for this purpose. Since the beat is produced by the mixing of mutually incoherent radiation, the phase of the beat current could be expected to fluctuate in a period of the order

of the coherence time for each Zeeman component; but the power at the beat frequency depends on the square of the current and this does not vanish on averaging—though the effect is very feeble indeed. A basic assumption made by Forrester *et al.*, in the explanation of the experiment, is that the probability of emission of an electron at the photo-surface is proportional to the square of the electric field strength of the incident radiation—rather than the sum of the intensities of the two spectral lines separately. From the comments on this paper it appeared that the state function of a photon could cover two frequencies; however, when an experiment to determine the frequency of the photon is performed it would be found to be in one or the other frequency, and beat phenomena

could not simultaneously be detected. On the other hand, in an experiment where the beat phenomena are detected it would be impossible to say whether the individual photons are of one or the other frequency.

1. Wolf, E., *Proceedings of a Symposium on Astronomical Optics*, North Holland Publishing Co., Amsterdam, 1956, pp. 177.
2. Pancharatnam, S., Unpublished.
3. Adam, A., Janossy, L. and Varga, P., *Acta Hungarica*, 1955, 4, 301.
4. Hanbury Brown, R. and Twiss, R. Q., *Proc. Roy. Soc.*, 1957, 243 A, 291.
5. —, *Nature*, 1957, 180, 324.
6. Purcell, E. M., *Ibid.*, 1956, 178, 1449.
7. Forrester, Gudmundsen and Johnson, *Phys. Rev.*, 1955, 99, 1691.

## THE XII GENERAL ASSEMBLY OF THE INTERNATIONAL GEODETIC AND GEOPHYSICAL UNION

**T**HE International Geodetic and Geophysical Union is the largest among the international scientific bodies and includes scientists from 65 countries. The XII General Assembly held recently in Helsinki was singular in that it was the first major get-together of geophysicists after the I.G.Y. It was attended by about 2,000 scientists from 45 countries.

The bulk of the Assembly's programme was devoted to discussions held in all the seven associations of the Union, *viz.*, geodesy, meteorology, seismology and terrestrial physics, geomagnetism, physical oceanography, pure hydrology and volcanology.

The geodesists discussed the results of observations of artificial Earth satellites which have added much to our knowledge of the Earth's shape. They also examined techniques of gravimetric surveys from a flying plane.

The meteorologists exchanged new data on the general circulation of air in the atmosphere, and suggested for the first time charts of circulation covering the atmosphere to an altitude of 100 kilometres.

The Geomagnetism Association was highlighted by a discussion of the geophysical phenomena observed in July 1959. July had been chosen for a comprehensive correlation of the various phenomena studied under the I.G.Y. programme. Among other things, variations in the terrestrial magnetic field were viewed against changes in the intensity of cosmic radiation, ionospheric processes, and solar activity. July 1959 was of particular interest in that a

sharp ten-day outburst took place on the Sun that month. As was found out in the discussion, the streams of tiny particles coming to the Earth from the Sun cause, though in a negligible measure, the Earth's speed of rotation to slow down.

The seismologists took up problems relating to the structure of the Earth's lower crust and the layers that extend many hundred kilometres into the Earth's interior. A new finding was that the continents differ from each other not only in the structure of the crust, but also in the deeper envelope (mantle) of the Earth to a depth of at least 600 or 700 km. This discovery convincingly refutes the hypothesis of floating continents, for they are firmly anchored to the very deep zones of the globe. Intriguing results were obtained through seismographs placed for the first time on the bottom of the ocean at a considerable depth. While on mainland seismographs show what are known as microseisms, or continuous minute tremor of soil, caused, it appears, by winds, changing air pressure, and waves striking at the shores of mainland, complete quiet reigns supreme at the ocean's bottom. Thus underwater seismographs may be employed to detect very weak earthquakes which are usually obliterated by microseisms when monitored on mainland.

The oceanographers examined in detail and elaborated their joint programme involving studies in the Indian Ocean.

The Association of Hydrology summed up the results of the I.G.Y. programme. A com-

parison of all the observations suggested the conclusion that at present the glaciers on the Earth's surface are gradually, though very irregularly shrinking.

The volcanologists had a circumstantial discussion on the origin of volcanos and their relation to the magmatic bodies solidified in depth.

Future plans and programmes for international co-operation also received a good share of attention at the Assembly. The success of the I.G.Y. encouraged the geophysicists to widen co-operation in the study of our planet still more. It was agreed to undertake a joint programme of research during the period of the lowest solar activity expected in 1963 and 1964. The programme will cover a whole range of magnetic phenomena (geomagnetic and ionospheric phenomena, auroral displays, solar activity and cosmic rays). Unofficially dubbed "the little I.G.Y.", the programme will be a very valuable addition to the "greater I.G.Y." which, as will be recalled, coincided with the period of the highest solar activity. Another project slated for the period of weakened solar activity is a world-wide magnetic survey.

Great interest was evoked by what is known as Project Upper Mantle, a programme of intensive studies into the globe's layers lying beneath the crust. They extend from a few ten kilometres below the surface to as deep as about 1,000 kilometres. The Earth's upper mantle is remarkable; for that is where matter moves, changes its volume, physical and chemical state to give rise to tectonic movements, volcanic eruptions and other phenomena in the Earth's crust.

The causes of the crust's movements and volcanic activity still remain unknown. Project Upper Mantle will throw light on the causes, which will be of both purely scientific and great applied value. Apart from a variety of geo-

physical methods, use will be made of the most straightforward technique—that of drilling super-deep wells through the entire thickness of the Earth's crust. The drilling technique can be employed most favourably on the bottom of the oceans where the crust is six kilometres or so thick as against the 35 kilometres under the continents.

Under the I.G.Y., the effort was mainly concentrated on the atmosphere, the ionosphere, the Sun and the space immediately around the Earth, while phenomena in the Earth's solid body figured rather modestly on the programme. Naturally, emphasis should now be placed on the globe's areas which give birth to metals—the basis of modern technology, and where earthquakes and mountains take their origin.

The Assembly agreed on a joint study into the so-called tsunamis—the formidable tidal waves caused by earthquakes, so as to forecast them in good time. It was also decided to compile a seismotectonic map of Europe.

The Assembly elected new officers of the Union and of its Associations. Vladimir Belousov, Corresponding Member of the Soviet Academy of Sciences, was elected the Union's President for the next three years' term. Professor Bartels (Western Germany), an eminent magnetologist, and Professor Caplan (United States), an authority on the upper atmosphere, were elected Vice-Presidents of the International Geodetic and Geophysical Union. Seven Soviet scientists, noted for their valuable contributions to the science of the Earth, were elected Vice-Presidents in the seven Associations.

The next, XIII, General Assembly of the I.G.G.U. will be held in the United States in three years. It will coincide with the centenary of the Geodetic Association, the oldest constituent of the Union.—(Courtesy of the USSR Embassy in India).

## SOLAR RADIATION PRESSURE ON SATELLITES

**T**HEORETICAL predictions of the effects of solar radiation pressure have been demonstrated by Echo I, the U.S. balloon satellite. Measurements of the orbit of Echo I computed at the Smithsonian Observatory have confirmed the theory concerning the impact of solar pressure on satellites. These measurements show that the lowest point of the orbit is being pushed towards the earth by the rays of the Sun. The present rate of this movement is  $1\frac{1}{2}$  miles each 24 hours. However, calculations indicate that

this rate will soon decrease and then reverse. Accurately predicting the effect of solar pressures on large, light-weight satellites with different orbits and launch times will aid in determining optimum orbit and launch time for accomplishing a specific mission. In certain orbits, a small variation in launch time can result in a great difference in satellite life because of solar pressure.—*Electronics*, September 23, 1960.

## NOBEL PRIZE AWARDS

## PHYSICS

**T**HE 1960 Nobel Prize for Physics has been awarded to Prof. Glaser of the Ann Arbor University, Michigan, for his discovery of the "bubble chamber". Prof. Donald Arthur Glaser was born in 1926 in Ohio and was in the University of Michigan from 1949 to 1960. Presently he has joined the research group at Berkeley, California.

The bubble chamber is an invaluable tool in modern nuclear research and it has led to many discoveries regarding fundamental particles and their behaviour. Knowledge of elementary particles has to a great extent been obtained by studying the tracks left by projectiles of nuclear fragments passing through matter. The bubble chamber, like Wilson's cloud chamber and Powell's nuclear emulsion, enables photographs of the tracks of charged particles to be obtained.

As is well known, in the cloud chamber a saturated vapour is supercooled by sudden expansion, when the vapour becomes supersaturated, unstable and likely to condense. If at this stage an ionizing particle enters the chamber, the ions which are produced in the wake of the particle act as condensing centres for droplets to be formed, and the track of the particle thus becomes visible and can be photographed.

However, cloud chambers, although they are an invaluable aid in the study of low energy particles, become unsuitable in the study of highly penetrating radiations or high-energy particles because their absorption in the chamber is low consequent on the low density of the material in it. Powell's photographic emulsion technique provides the required density but suffers from the disadvantage that the emulsions consist primarily of silver and bromine, i.e., atoms of complex nuclear structure. Still they are the most useful in the study of very high-energy particles and led to the discovery of the pi-meson.

As early as 1950, Glaser started work on a method of registering particle tracks which could bridge the wide gap in range remaining between cloud chamber and emulsion. He conceived the idea that such an instrument could be made by taking advantage of the instability of superheated liquids against bubble formation

just as Wilson's cloud chamber uses the instability of supercooled vapours against the formation of droplets. He reasoned that the passage of ionizing particles through such a superheated liquid might cause local ionization centres which could create condensation nuclei for the formation of bubbles. Based on these ideas Glaser succeeded in constructing his first liquid bubble chamber.

Glaser's first bubble chamber (1952) was a thick-walled cylindrical pyrex bulb 3 cm.  $\times$  1 cm. maintained at about 130° C. and containing liquid diethyl ether under a pressure of 20 atmospheres. By releasing a valve the pressure dropped to one atmosphere when the ether became superheated, bringing the chamber to the "sensitive" state. The liquid normally remained quiet for several seconds (waiting time), after which eruptive boiling occurred. To obtain the tracks the chamber was placed in a vertical cosmic ray telescope, which triggered a flash-tube and camera arrangement if a particle passed through during the "waiting time". Glaser obtained several photographs of cosmic-ray particles in this way and the important potentialities of the bubble chamber as a nuclear particle detector became apparent. It should be noted that a bubble track can be observed only during the brief period (a few milliseconds) before general boiling begins throughout the liquid.

Since the first experiments with diethyl ether, other liquids such as isopentane, benzene, sulphur dioxide and ethyl alcohol have been found to be similarly radiation sensitive. These successes led to the development by Glaser of the bubble chamber with liquid hydrogen, which has the obvious advantage of simplicity in interpretation of results as here a pure proton target is presented to the incoming particle. Liquid hydrogen bubble chambers, especially of large size, play a most important part today in high-energy physics involving the use of giant machines for particle acceleration. University of California, Berkeley, has a six-foot long liquid hydrogen bubble chamber that has been in operation for some time. Brookhaven National Laboratory has an eighty-inch long chamber under construction. CERN at Geneva will be having one two-metres long. Bubble chambers have also been made which use Helium, Xenon, Freon, Propane, etc. Moscow laboratory has a 600-litre Freon Bubble Chamber.



CHEMISTRY

The Nobel Prize for Chemistry has been awarded to Prof. Libby for "his method of using carbon-14 for age determination in archaeology, geology, geophysics and other branches of science". Professor Willard Frank Libby was born in 1908 in Colorado, and studied and graduated at the University of California in Berkeley where he became successively Instructor, Assistant, and Associate Professor. In 1945 Prof. Libby was appointed Professor of Chemistry in the Institute of Nuclear Studies, University of Chicago.

It was in the Berkeley Cyclotron Laboratory in 1934 that Libby made his successful experiments on the production of radiocarbon  $C^{14}$  by neutron bombardment of nitrogen according to the reaction:  $n + N^{14} \rightarrow H + C^{14}$ . Subsequently Prof. Libby succeeded in developing an effective method of producing  $C^{14}$ , and studying its radioactive properties. He showed that by beta-decay  $C^{14}$  changed to  $N^{14}$ , with the half-life period of  $5,568 \pm 30$  years. Further, he established by experimental studies that such processes as were obtained in the laboratory, namely, production of energetic neutrons (by cosmic rays) and their capture by nitrogen atoms (of the atmosphere) yielding radioactive carbon  $C^{14}$ , are going on all the time in the upper regions (6 to 7 miles) of the earth's atmosphere.

These fundamental studies led Prof. Libby and his collaborators to develop (1948-50) the famous techniques of radiocarbon dating (see *Curr. Sci.*, 1959, 28, 271). Dating by radiocarbon has assumed great importance in recent years and progress in this field has been rapid. With improved techniques in measurements this method has held out to archaeologists and Quaternary geologists the possibility of absolute dating for organic materials from deposits between 1,000 A.D. and 20,000 B.C. The fascinating feature of this field of study lies in the fact that it brings together such remotely related interests as atomic physics and history of human cultures.

MEDICINE

Prof. Peter Bryan Medawar, Professor of Zoology, University College, London, and Sir Frank Macfarlane Burnet, Director, Walter and Eliza Hall Institute for Medical Research, Melbourne, Australia, have been jointly awarded

the 1960 Nobel Prize for Medicine for their discovery of "acquired immunological tolerance".

Macfarlane Burnet is amongst the most outstanding workers in the field of viruses, and his researches extending over a period of thirty years have significantly added to our knowledge of bacteriophages. During the past few years he has turned to the study of fundamental aspects of immunity and in his recent book *The Clonal Selection Theory of Acquired Immunity* he has presented a novel and perhaps productive way of approaching the problems of immunity and especially the medical problems which arise when immunological responses are distorted.

Prof. Medawar is distinguished for his studies on the biology of growth processes, senescence, and preservation and transplantation of tissues. His intensive work on the problems of the homograft reaction has led to the discovery of acquired immunological tolerance. A graft from one individual to another will not in general survive (except with identical twins). Medawar showed that this was due to the fact that the graft induces the formation of an immune reaction by the host. The power to react against homografts was, however, found to be prevented from developing if the host animal was infected very young with cells from the donor strain.

In principle the homograft reaction might be prevented or circumvented either (1) by modifying the graft in such a way as to make it acceptable to its host, or (2) by modifying the host in such a way as to make it tolerate the graft. Of the two, the second possibility is more promising. The most important treatment in this respect is that which is founded on the principle of "immunological tolerance". New-born or embryonic animals are so affected by exposure to grafts of foreign cells that they learn to tolerate tissues of the same genetic make-up when they are transplanted later in life. 'Acquired tolerance' comes about naturally in those dizygotic twins which share a common circulation *in utero*; but many obstacles must be overcome before any such principle could be applied in surgical practice. The chief medical importance of the phenomenon of tolerance is to show that the homograft problem is indeed solvable in principle; and the ultimate goal of medical research into transplantation is to bring about a state of tolerance in the adult subject.

## THE REFLECTOR TELESCOPE OF THE TAUTENBURG OBSERVATORY

**T**HE new 2-metre reflector telescope installed at the Tautenburg Astronomical Observatory (near Jena) on October 19, 1960, is unique in many respects. The telescope made by VEB Carl Zeiss JENA on the lines suggested by Dr. Kienle combines different optical systems and permits study of celestial objects both collectively and individually.

Optically, the construction of the Telescope is governed by the Schmidt system in which a photographic assembly of 4-metre focal length and an aperture ratio of 1:3 is formed consisting of a spherical main mirror 2 metres and a correction plate 1.34 metres in diameter. In this form, the Schmidt system of the Telescope represents the largest in the world and allows investigation of wide regions of the firmament, recording them on  $24 \times 24$  cm. photographic plates.

For the individual examination of celestial objects, the Quasi-Cassegrain system is available, where the main mirror combines with a hyperdeformed convex counter-mirror 400 mm. in diameter, imparting to the system a focal length of 20 metres. This system is predominantly used in photoelectric photometry and spectrography.

The Quasi-Coude system is constructed on similar lines but is distinguished by a longer focal length of 92 metres and a fixed place of observation where instruments of highest sensitiveness may be installed, such as, for instance, high dispersion spectrographs which are not required to take part in the motion of the telescope during the observation.

Mechanically, the construction of the Universal Telescope consists of a tube body of roughly ten metre length and square cross-section and of a fork-type of mounting device (Fig. 1). This mounting device is of the equatorial type which permits of directing the tube to the desired object and keeping the same within the visual field during the time of observation. The moving parts of the Telescope weigh 65,000 kg. and special provisions in the form of hydraulic thrust bearings permit the telescope to follow the stars with the precision of an astronomical clock. Floating on a film of oil of 0.05 mm. thick, the telescope is moved with the requisite accuracy by a precision worm wheel which is 2,160 mm. in diameter and the teeth of which average less than 0.5 seconds of arc from the theoretical distance. By means of an electrical transmission device the movement of the heavy tube body (26,000 kg.) about

the declination axis, same as the movement about the polar axis, is transmitted to a central and several branch switchboards from which the instrument is fully electrically adjusted for the astronomical co-ordinates of the objects under observation. By means of a large number of compensation devices the adjustment and seating of the optical elements will be preserved with greatest accuracy in all positions of the Telescope and under varying temperature conditions.

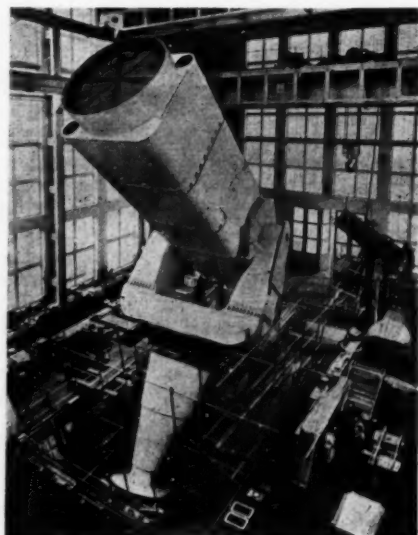


FIG. 1

The main mirror weighing 2,370 kg. as well as the correction plate, made of UV-transmissive optical glass, having a thickness of 38 mm. and the different auxiliary mirrors were cast by the VEB JENAER Glaswerk Schott und Gen. The grating spectrographs, still in the course of production, will give stellar spectra of a maximum length of 1,500 mm. The camera mirror of the Coude spectrograph will be 1,200 mm. in diameter thus approaching in its dimensions that of a medium size telescope.

The complete equipment will be housed in an observatory dome 20 meters in diameter and of a total weight of 175 tons. The dome will be heat insulated and maintained at a constant temperature—the night temperature—thus guarding the mechanical and optical parts against an adverse influence of temperature fluctuations.



# ZENITH ANGLE RESPONSE FOR INCLINED MESON TELESCOPES

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**D**IRECTIONAL measurements of cosmic ray intensity are mostly carried out by Geiger Counter Telescopes. In order to correlate the daily variation of  $\mu$  meson intensity measured by such telescopes with anisotropy of primary cosmic radiation, it is essential to know their response characteristics.

Response characteristics of a telescope for any direction can be calculated by knowing the sensitive area of the telescope for the particles coming from that direction and the intensity of radiation in that direction. The sensitive area of a telescope is maximum for particles coming in a direction perpendicular to the plane of the counter tray. A vertical meson telescope, for example, has a maximum sensitive area for particles incident from the vertical direction. A simple geometrical consideration shows that the solid angle available for particles coming in inclined directions is greater than the one available for those coming in vertical direction. Taking into account both these factors one can calculate the geometrical sensitivity  $G. S. (\theta)$  of any telescope arrangement for different values of the inclination  $\theta$  which the incoming cosmic ray trajectories make with the vertical. An expression for the same for meson telescopes of cubical geometry was obtained by Parsons.<sup>1</sup> Parsons' method was later extended by the present authors<sup>2</sup> to obtain an expression for the geometrical sensitivity of vertical counter telescopes having rectangular dimensions. Radiation sensitivity and Cumulative sensitivity were calculated assuming a zenith angle attenuation of the form  $I_\theta = I_0 \cos^2 \theta$  where  $I_0$  and  $I_\theta$  are cosmic ray intensities in the vertical direction and in a direction inclined to the vertical at an angle  $\theta$  respectively.

In the case of inclined telescopes, the calculation of response characteristics is rather complicated. No annular ring around the axis of the telescope corresponding to a particular value of  $\theta$ , the angle of inclination of the incoming particle with respect to the zenith, will have uniform intensity all round the ring. However, considering the problem only in the plane in which the angular opening of the telescopes is narrower (usually E-W plane), we have determined the response of inclined telescopes for different values of  $\theta$ .

Consider a geometrical arrangement in which the top and bottom trays are represented by XY

and AB respectively. Let the breadth  $AB = XY = d$  and the length of the telescope be "l". Let the separation between the two trays be  $BY = AX = a$ . The axis of the telescope is inclined to the vertical at an angle  $\alpha$  so that the breadth  $d$  is inclined at an angle  $(90 - \alpha)$  to the vertical while the length  $l$  is horizontal. Depending on the value of  $\theta$  with respect to  $\alpha$ ,  $\theta$  can be grouped into two ranges for each of which the formula to be used for deriving the geometrical sensitivity will be different.

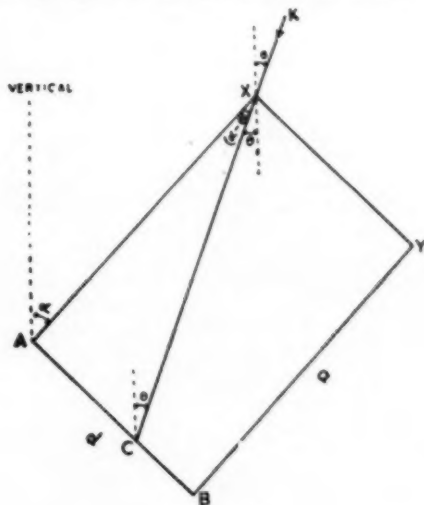


FIG. 1

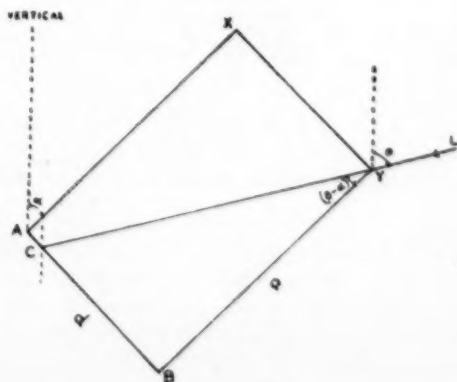


FIG. 2

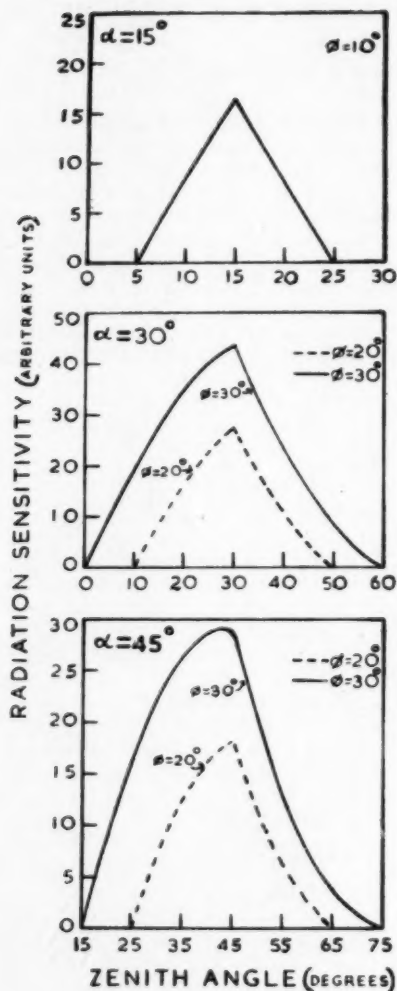


FIG. 3

Fig. 3. Zenith angle dependence of Radiation Sensitivity for meson telescopes inclined to the vertical at an angle  $\alpha$  and having a semi-angle of opening  $\phi$  in the narrower plane. Fig. 4. Zenith angle dependence of Percentage Cumulative Sensitivity for meson telescopes inclined to the vertical at an angle  $\alpha$  and having a semi-angle of opening  $\phi$  in the narrower plane.

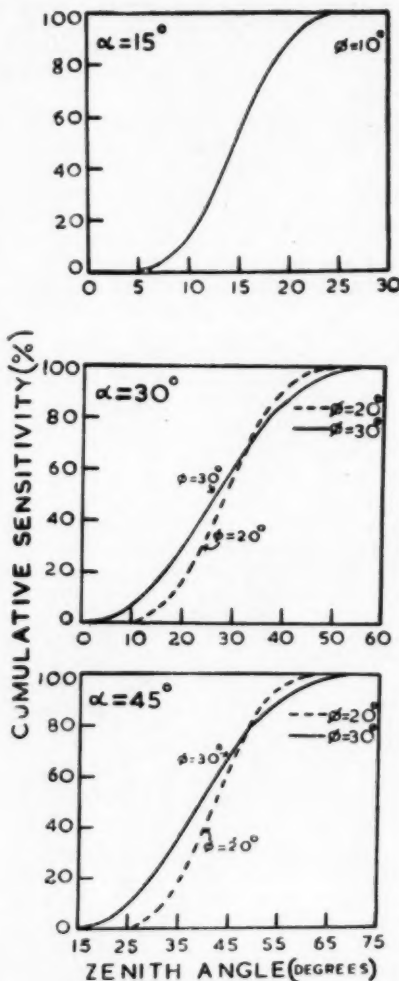


FIG. 4

Case A.  $\theta \leq \alpha$ :—Consider cosmic rays incident at a zenith angle  $\theta$ , where  $\theta \leq \alpha$ . In order to calculate the response, we have to calculate the area perpendicular to the path of the particle in each direction and multiply it by the intensity in that direction. From Fig. 1,

$$BC = AB - AC = d - a \tan(\alpha - \theta). \quad (1)$$

Projection of BC perpendicular to the ray KC

$$\begin{aligned} &= BC \cos(\alpha - \theta) \\ &= \{d - a \tan(\alpha - \theta)\} \cos(\alpha - \theta) \\ &= a \{\delta - \tan(\alpha - \theta)\} \cos(\alpha - \theta) \end{aligned} \quad (2)$$

where  $\delta = d/a$ .

Area perpendicular to the path of the particle

$$= a.l \{\delta - \tan(\alpha - \theta)\} \cos(\alpha - \theta). \quad (3)$$

When  $\theta = \alpha$ , the expression for the area reduces to  $(1 \times d)$  and when  $\theta = (\alpha - \tan^{-1} \delta)$ , the area becomes zero, thus satisfying the boundary conditions.

Radiation sensitivity in the direction of the particle is

$$R.S.(\theta) = a.l. \cos^2 \theta (\delta - \tan(\alpha - \theta)) \times \cos(\alpha - \theta) \quad (4)$$

if the intensity falls off with the zenith angle as  $\cos^2 \theta$ .

Case B.  $\theta \geq \alpha$ :—Consider the case when the particles are coming in the direction LY making an angle  $\theta \geq \alpha$  with the vertical.

From Fig. 2, it can be shown similarly that the radiation sensitivity of the telescope R.S. ( $\theta$ ) is given by

$$R.S.(\theta) = a.l. \cos^2 \theta (\delta - \tan(\theta - \alpha)) \times \cos(\theta - \alpha). \quad (5)$$

In Fig. 3, are plotted the radiation sensitivity for different inclined telescopes characterised by  $\alpha$ , the inclination of the axis of the telescope with the vertical, and  $\phi = \tan^{-1}(\delta)$ , the semi-angle of opening in the narrower plane.

Since the total counting rate  $N$  of a telescope is given by

$$N \propto \int_{(\alpha - \phi)}^{(\alpha + \phi)} R.S.(\theta) d\theta \quad (6)$$

the percentage contribution to the total counting rate of particles confined to the zenith angles between  $(\alpha - \phi)$  and any value  $(\alpha - \phi + \theta_0)$  is given by the cumulative sensitivity C.S., as

$$C.S. = \left[ 100 \int_{(\alpha - \phi)}^{(\alpha - \phi + \theta_0)} R.S.(\theta) d\theta \right] \div \left[ \int_{(\alpha - \phi)}^{(\alpha + \phi)} R.S.(\theta) d\theta \right] \quad (7)$$

The cumulative sensitivity for various zenith angles and for various values of  $\alpha$  and  $\phi$  is shown in Fig. 4.

An important result is that most of the radiation comes from a narrow cone along the axis

of the telescope. Thus for example for telescopes having a semi-angle of  $20^\circ$  in the narrower plane and inclined to the vertical at  $45^\circ$ , the mean inclination of all radiation recorded is at  $42.5^\circ$  and 50% of the recorded radiation is incident within a range of approximately  $\pm 5.5^\circ$  of this mean value.

Since the problem has been considered here only in one plane, viz., the plane in which the angular opening of the telescope is narrower, the present method is only approximate. However, the angle of maximum response calculated with the present method for a vertical telescope having semi-angles of opening  $20^\circ \times 45^\circ$  turns out to be  $13.0^\circ$  which compares favourably with the value  $13.5^\circ$  obtained by accurate calculations described in our earlier communication.<sup>2</sup> Also, the present method gives an angle of maximum response of  $42.0^\circ$  for Parsons<sup>3</sup> telescopes of dimension  $1m. \times 1m. \times 1\frac{1}{2}m.$  and inclined at  $45^\circ$  to the vertical, which is almost the same as Parsons' calculated value, viz.,  $42.5^\circ$ . It seems, therefore, that the approximation involved in the present method does not give errors exceeding  $\pm 0.5^\circ$  even in case of wide-angle telescopes.

It may be concluded from the above results that for narrow-angle telescopes (semi-angles less than  $20^\circ$ ) inclined to the vertical, the maximum response of the telescope is almost along the axis of the telescope. Also, about 50% of the recorded particles are confined to within  $\pm 5^\circ$  of the axis of the telescope.

The authors are grateful to Prof. V. A. Sarabhai for helpful discussions and to the Atomic Energy Commission of India for financial assistance.

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## ELECTRONIC NERVE CELL

A TINY electronic "nerve cell" that duplicates some functions of the human nervous system and brain has been developed by Aeronutronic, a division of Ford Motor Company. The experimental device looks like a tiny ring, about a quarter of the size of a farthing, and is called MIND (Magnetic Integrator Neutron Dupli-cator). It consists of an outer ring and an inner

wired magnetic ceramic core, and acts as a nerve to relay stimuli and as a memory unit to store "facts" or "experience" fed to it. The makers stress that they are still a very long way from building anything even approaching the complexity of the human brain which has nearly 10,000 million neurons or nerve cells.—*I.S.L.O. News Letter*.

## LETTERS TO THE EDITOR

DETECTION OF COPPER BY A  
NEW SPOT TEST

VARIOUS oximes obtained from phenolic aldehydes and ketones were examined as reagents for the detection and determination of copper by Ephraim.<sup>1</sup> Raju and Neelakantam<sup>2</sup> recommended resacetophenone-oxime for the determination of copper. The corresponding phenylhydrazones, however, has not so far been examined as reagent for this metal.

The reagent is easily prepared by refluxing resacetophenone in alcoholic solution with phenylhydrazine dissolved in dilute acetic acid and sodium acetate. The product is crystallised from aqueous alcohol using animal charcoal. It is obtained as pale yellow needles, m.p. 159° C. It is readily soluble in alcohol. The alcoholic solution is fairly stable and gradually develops a deep brown colour.

The following results were obtained with this new reagent and copper:—(1) There is no reaction in acid or neutral medium. (2) It yields in ammoniacal medium a green precipitate with small quantities and a chocolate-brown one with larger amounts of copper. (3) The concentration of ammonia, the amount of reagent used and the order of addition influence the results. (4) With sodium hydroxide, the precipitate is bright red in concentrated solutions only. (5) The results obtained in ammoniacal medium are far more easily reproduced than with sodium hydroxide.

The following procedure was adopted for the test:—A drop of the test solution is placed on the spot plate followed by 2 or 3 drops of dilute ammonia (4-6 N) and two drops of a 10% solution of the reagent in alcohol. With very small quantities the reagent slowly develops a green colour only.

Limit of identification 0.5 γ.

Limit of dilution 1:1,00,000.

The test is highly sensitive. Since cadmium gives no precipitate, the test is useful for the detection of copper in presence of cadmium in qualitative analysis.

Department of Chemistry, P. UMAPATHY.  
Sri Venkateswara University N. APPALA RAJU.  
College, Tirupati, September 22, 1960.

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NITRIFICATION OF OILED AND  
DEOILED CAKES

THE real value of nitrogenous manures is judged by the rate at which the nitrogen becomes available to the crop, generally, in the form of nitrates.<sup>1</sup> It is known that oilcakes take time to decompose and become useful to plants as they have to undergo physical, chemical and biological changes when added to the soil. There are various biological changes to which these cakes are subjected and the ultimate product of these biological changes is formation of nitrates.

Deoiling improves nitrification.<sup>2</sup> The present study was undertaken to find out the performance of different cakes from the point of view of nitrifiability and the effect of deoiling on the same.

The oilcakes used in the experiment were as follows:—

Name of the cake	Percentage of nitrogen
1 Groundnut cake ( <i>Arachis hypogea</i> )	7.05
2 Safflower cake ( <i>Carthamus tinctorius</i> )	2.95
3 Castor cake ( <i>Ricinus communis</i> )	4.44
4 Karanj cake ( <i>Pongamia glabra</i> ) ..	4.31
5 Til cake ( <i>Sesamum indicum</i> ) ..	5.92

Sufficient quantity of each of the cakes, both with oil and deoiled to yield 100 mg. of nitrogen per 100 g. of medium black soil was thoroughly mixed. The moisture content of the soil was maintained at 1/3 saturation capacity throughout the period of experiment. Periodically samples were drawn and were analysed for nitrate nitrogen by the Richardson's modification of Olsen's method as described by Piper.<sup>3</sup> The percentages of nitrogen nitrified during the first 45 days, and the second 45 days' period are given in Table I.

TABLE I

Treatments	Percentages of nitrogen nitrified			
	First 45 days' period		Second 45 days' period	
	With oil	Deoiled	With oil	Deoiled
1 Groundnut cake	10.90	8.86	59.45	51.37
2 Safflower cake	10.10	15.20	22.74	24.76
3 Castor cake ..	13.16	13.67	44.71	59.62
4 Karanj cake ..	14.82	8.94	80.64	47.89
5 Til cake ..	15.19	11.41	72.36	53.10

The data show that amongst the cakes, Karanj cake with oil nitrifies most and is followed by Til cake with oil.<sup>4</sup> The superiority in nitrification shown by these cakes, though slight in the first 45 days' period is quite appreciable in the second 45 days' period. The Safflower cake is slowest in nitrification.<sup>5-7</sup>

No striking beneficial effect on nitrification due to deoiling of cakes has been observed except in the case of Castor cake.<sup>8-10</sup>

Chemical Res. Laboratory, B. N. GANDAGULE.  
College of Agriculture, N. N. BADHE.  
Poona-5, August 8, 1960. D. K. BALLAL.

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## SYNTHESIS OF CHLOROSUBSTITUTED CHALKONES

Various chalkones containing halogen in the ketonic part are known (see, for example, Shah and Parikh, *J. Ind. Chem. Soc.*, 1959, 36, 726).

Chalkones containing halogen in the aldehyde part have not been extensively studied. The present work was undertaken with a view to synthesizing chalkones containing halogen atom in the aldehyde part.

Table I contains the various chalkones synthesized by the authors. 2:4-Dichlorobenzaldehyde was available commercially while 3:5-Dichloro-6-hydroxybenzaldehyde was prepared according to a British patent (Patent No. 794885, *Chem. Abstr.*, 1959, 53, 320), in good yield. These aldehydes were condensed with acetophenone, 0-hydroxyacetophenone, resacetophenone, quinacetophenone, 1-hydroxy-2-naphthone and 2-hydroxy-5-chloroacetophenone respectively.

### GENERAL METHOD OF CHALKONE FORMATION

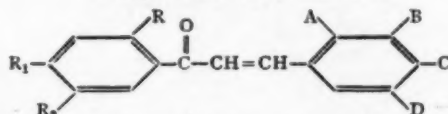
An alcoholic solution of the appropriate ketone was mixed with equimolar proportion of the aldehyde and to the mixture was added 40% solution of potassium hydroxide slowly with continuous stirring. The reaction mixture was left overnight at room temperature and poured into ice-water and finally acidified with concentrated hydrochloric acid. The chalkone precipitated was washed with water, dried and crystallised from ethanol. The yields of chalkones varied between 60 and 70%.

Further work is in progress. Authors thank Dr. J. J. Trivedi and Dr. N. M. Shah for interest in the work.

Chemistry Department,  
St. Xavier's College,  
Ahmedabad-9, July 9, 1960.

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TABLE I  
Halogen substituted chalkones



No.	R =	R <sub>1</sub> =	R <sub>2</sub> =	A =	B =	C =	D =	M.P.	Formula	Analysis for Cl %	
										Calculated	Found
1	H	H	H	Cl	H	Cl	H	97°	C <sub>15</sub> H <sub>10</sub> Cl <sub>2</sub> O	25.6	25.5
2	HO	H	H	Cl	H	Cl	H	149°	C <sub>15</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>2</sub>	24.2	24.2
3	HO	HO	H	Cl	H	Cl	H	203-4°	C <sub>15</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>3</sub>	23.0	23.1
4	HO	H	HO	Cl	H	Cl	H	66°	C <sub>15</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>3</sub>	23.0	23.0
5	HO	H	Cl	Cl	H	Cl	H	170°	C <sub>15</sub> H <sub>9</sub> Cl <sub>3</sub> O <sub>2</sub>	32.5	32.3
6	1-hydroxy-2-naphthone	Cl	Cl	H	Cl	H	H	160°	C <sub>19</sub> H <sub>12</sub> Cl <sub>2</sub> O <sub>2</sub>	20.7	20.7
7	HO	H	H	HO	Cl	H	Cl	203°	C <sub>15</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>3</sub>	23.0	22.8
8	HO	HO	H	HO	Cl	H	Cl	78°	C <sub>15</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>4</sub>	21.8	21.8
9	HO	H	HO	HO	Cl	H	Cl	86°	C <sub>15</sub> H <sub>10</sub> Cl <sub>2</sub> O <sub>4</sub>	21.8	21.7
10	HO	H	Cl	HO	Cl	H	Cl	235°	C <sub>15</sub> H <sub>9</sub> Cl <sub>3</sub> O <sub>3</sub>	31.0	29.7
11	1-hydroxy-2-naphthone	HO	Cl	H	Cl	H	Cl	59°	C <sub>19</sub> H <sub>12</sub> Cl <sub>2</sub> O <sub>3</sub>	19.8	19.6



# INHIBITION OF ENDOTROPHIC SPORULATION IN *BACILLUS CEREUS* IN RELATION TO THE INHIBITION OF GROWTH

ENDOTROPHIC sporulation or the ability to sporulate in an environment which does not support growth has been recognised as a phenomenon which occurs to a variable extent in most aerobic sporeforming bacteria. Sporulation of this nature can be inhibited and it has been postulated on the basis of results with some metallic salts and organic acids, that most growth-inhibiting substances would at the same or lower concentrations, also probably inhibit endotrophic sporulation.<sup>1</sup> In further experiments in this laboratory, the validity of this concept has been tested by two methods. (a) By studying the comparative ability of concentrations of several bacterial inhibitors to inhibit growth and endotrophic sporulation. (b) By developing strains resistant to varying concentrations of a bacterial inhibitor (streptomycin) and studying the comparative inhibition of endotrophic sporulation by this inhibitor in such resistant strains; if the inhibition of endotrophic sporulation were to be truly related to the inhibition of growth, it may be expected that higher concentrations of streptomycin would be required to inhibit endotrophic sporulation in the resistant strain than would be required to inhibit it in the sensitive one.

The strains of *B. cereus* resistant to varying amounts of streptomycin were obtained by methods based on the gradient plate principle of Szybalski and Bryson.<sup>2</sup> Other experimental techniques and the scoring of growth and sporulation were as described in our earlier publication.<sup>1</sup>

TABLE I

The comparative ability of some chemical compounds to inhibit growth and endotrophic sporulation in *Bacillus cereus*

Inhibitory compound		Minimum concentration ( $\mu\text{g./ml.}$ ) which completely inhibits	
		Growth	Endotrophic sporulation
Boric acid	..	5,000	4,500
Chlortetracycline	..	50	50
Formaldehyde	..	800	800
Hydrogen peroxide	..	30,000	2,600
Penicillin	..	75,000	50,000
Potassium cyanide	..	2,000	1,000
Sodium azide	..	250	250
Sodium fluoride	..	1,000	1,000
Streptomycin	..	2.0	1.5

In Table I is presented the respective concentration of inhibitors that prevent growth and endotrophic sporulation. It will be observed that in most cases concentrations that inhibit sporulation are either the same or slightly lower than those that inhibit growth. This supports our earlier observations. The sporulation response of the parent strain of *B. cereus* sensitive to 1.5 microgrammes of streptomycin per ml., and three resistant strains derived from it (resistant respectively to  $10^2$ ,  $10^3$  and  $10^4$  microgrammes per ml.) to varying concentrations of streptomycin when held in distilled water, is presented in Fig. 1. The concentrations of

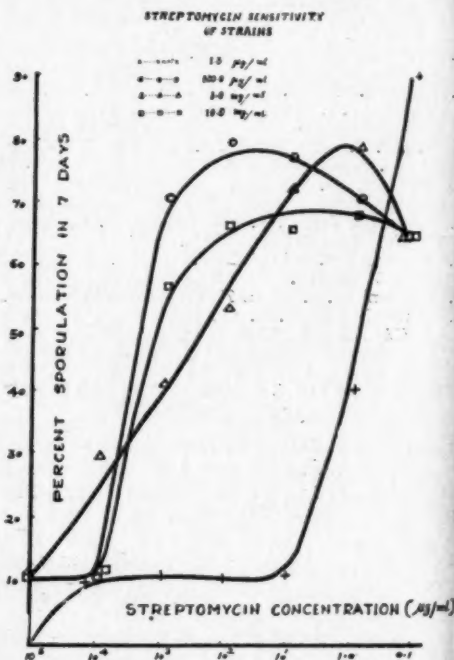


FIG. 1

streptomycin required to inhibit sporulation in the resistant strains are much higher than those required for the sensitive strain. No quantitative relationship is however detectable between the degree of streptomycin resistance and susceptibility to the inhibition of sporulation. This may be explained on the basis that different genetic determinants are affected in each strain, for it is known that streptomycin resistance is a property which is determined by several discrete mutations that afford different degrees of resistance.<sup>3</sup>



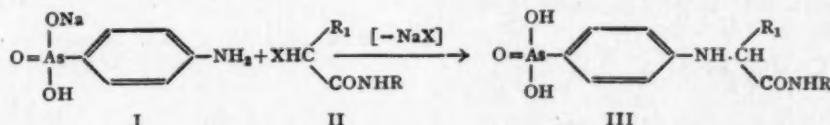
Microbiology Department, DOLLY H. KANGA.  
S. B. Garda College and V. IYER.  
B. P. Baria Science Institute,  
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# INTERACTION OF ATOXYL WITH THE HALOGEN DERIVATIVES OF ACETOACET ARYLAMIDES AND CYANACET ARYLAMIDES (PARTS I AND II)

MORGAN and Walton<sup>1</sup> condensed *p*-arsanilic acid with carbethoxyacetyl chloride and obtained *p*-arsonomalonanilate. Kennedy<sup>2</sup> prepared compounds of the type,  $H_2O_3As \cdot C_6H_4NHCH(CONHR)_2$ , by the interaction of *p*-arsanilic acid with bromo-malon alkylamides and noted that the former could not be condensed with some bromo amides. In a similar way Naik, Trivedi and Mehta<sup>3</sup> condensed atoxyl (sodium *p*-aminophenylarsonic acid) with bromo-malon arylamides, wherein they also noted that the former did not react with dichloromalon arylamides. B. Pathak and T. N. Ghosh<sup>4</sup> prepared organo-arsenicals by condensing acetanilide and *p*-arsanilic acid in presence of  $PCl_3$  or  $POCl_3$ .

In the present work atoxyl (I) is allowed to react with the respective chloro<sup>5</sup>-bromo- and iodo<sup>6</sup>-derivatives of acetoacet arylamides, as well as with the bromo<sup>7</sup>- and iodo<sup>6</sup> derivatives of cyanacet arylamides (II), where, in each case, the halogen atom of the amide reacted with a hydrogen atom of the amino group of atoxyl to give *p*-arsonoanilino derivatives of the corresponding amides (III) as under:—



(where, X = chloride, bromide or iodide radical; R = phenyl, tolyl, xylyl or naphthyl radical;  $R_1 = \text{COCH}_3$  or CN group).

Mono halogen derivative of acetoacet arylamide or of cyanacet arylamide (0.01 M), dissolved in a minimum quantity of alcohol to which was added atoxyl (0.01 M), dissolved in 5 ml. of water. The reaction mixture was then refluxed on a water-bath for 3 hrs. in case of chloro-, or bromo-, derivatives; while for  $\frac{1}{2}$  hr.

in case of iodo derivatives of the respective amides. The mixture, on cooling, gave the crude product, which, after charcoaling, was crystallised from aqueous alcohol in the form of tiny clusters. Bromo acetoacet arylamides are newly prepared by using bromine in acetic acid. Further work is in progress and the details will be published elsewhere.

One of the authors (J. M. T.) thanks the M.S. University of Baroda for the facility given to carry out the work.

Chemistry Department,  
Faculty of Science,  
M.S. University of Baroda,  
Baroda, August 1, 1960.

C. M. MEHTA.  
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# USE OF 2, 3, 5-TRIPHENYL TETRA- ZOLIUM CHLORIDE FOR THE MEASUREMENT OF DEHYDROGENASE ACTIVITY IN PLANT LEAF TISSUE

SINCE the property of turning red in active metabolising tissue was first reported by Kuhn and Jerchel (1941), 2, 3, 5-triphenyl tetrazolium chloride (hereafter abbreviated as tetrazolium salt) has been employed extensively as an indicator of high metabolic activity in a variety of plant and animal tissues. There are several enzymes which can be said to be indicative of metabolic activity in the tissue. However, the property that oxidases transfer hydrogen

directly to oxygen, while dehydrogenases transfer to an acceptor, has made possible the use of tetrazolium salt in the test for dehydrogenase activity.

Dehydrogenase activity in corn (*Zea mays*) leaf tissue was measured by observing the rate of reduction of tetrazolium salt. A set of five discs of 1 cm. diameter each was punched from leaf samples (plants raised in solution culture in a growth chamber) and transferred

to small vials with screw caps. Vials contained 2 ml. of 0.1% aqueous solution of tetrazolium salt. The vials were then stored in dark. At the end of 72 hours the insoluble carmine red triphenyl formozan formed was dissolved in 2 ml. methyl alcohol and extracted with 10 ml. toluene, by shaking vigorously. After centrifuging, the supernatant coloured toluene layer was taken with a mechanical pipette and absorbance measured at  $490\mu$  against a toluene blank extract, using Beckman model B spectrophotometer. Table I shows the effect of iron chlorosis on the dehydrogenase activity of the corn leaf tissue.

TABLE I  
Dehydrogenase activity in normal and chlorotic leaves of corn plant

Replication	Absorbance at $490\mu$ of reduced salt extract in toluene	
	Normal	Chlorotic
1	0.8000	0.0750
2	0.7600	0.2540
3	0.9400	0.4160
4	0.8600	0.2800
5	1.4000	0.3800
Mean	0.9520	0.2810

The amount of extractable reduced tetrazolium salt is more (as indicated by higher absorbance reading by about 55%) in healthy leaves than in the chlorotic ones. Hewitt and Agariwala (1952) used tetrazolium salt reduction test as an indicator of molybdenum deficiency in plant tissue.

It may be concluded that the iron deficiency affects markedly the dehydrogenase activity of leaf tissue. Therefore it is suggested that the tetrazolium salt reduction test may be employed as indicative of iron deficiency in plant leaf tissue.

(This work was conducted at the Utah State University, Logan, USA.)

Agric. Chemistry Section,  
College of Agriculture,  
Dharwar, August 6, 1960.

N. G. PERUR.

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## STUDIES IN MEDICAL MYCOLOGY

### VI. A Note on the Enzymes of Two Common Dermatophytes

As early as 1895 Macfadyen<sup>1</sup> found an enzyme of proteolytic nature in the culture fluid of a dermatophyte *Trichophyton topsurans*. Bodin and Lenormand<sup>2</sup> found several extra-cellular enzymes in *Microsporum* and *Achorion* and Tate<sup>3</sup> reported the presence of respiratory, proteolytic and lipolytic enzymes along with carbohydrases and ureases in the members of chief groups of dermatophytes. Nickerson<sup>4</sup> suggested the presence of d- and l-amino-acid oxidases and aminases in dermatophytes which was later successfully demonstrated by Bentley<sup>5</sup> in 1951. Some work has been done in India on enzymes of dermatophytes principally utilising histochemical methods (Banerjee et al.<sup>6</sup> and Bhattacharya et al.<sup>7,8</sup>).

The present investigation was undertaken to study the more important intra-, extra-cellular enzymes of *Trichophyton rubrum* and *Trichophyton mentagrophytes* the two most prevalent skin pathogens of Uttar Pradesh collected by Das Gupta and Shome.<sup>9</sup> Pure monohyphal cultures of these forms were utilised for the study. The enzyme assay was done qualitatively as well as quantitatively wherever possible. All the tests were carried out *in vitro* by utilising the usual methods. For the preparation of enzyme extract the fungi were grown in 150 ml. Erlenmeyer flasks on 50 ml. of Sabouraud's broth at 37° C. for three weeks. The fungal mats were taken out after the requisite period of growth and thoroughly washed with double distilled water to free it from all adhering medium. They were then dried by pressing between sterilised folds of filter-papers. The dried mass was weighed and macerated with twice its weight of fine grade carborundum powder for 10 minutes in chilled pestle mortar and eluted out with 5 ml. of distilled water. The resulting extract was finally diluted to 20 ml. per gram of material. It was centrifuged at 3,500 r.p.m. at 5° C. for 20 minutes. The opalescent supernatant liquid was poured out after centrifugation and stored in deep freeze at -20° C., to be used for the tests of intra-cellular enzymes. The filtrate obtained while separating the fungus mat from the broth media was collected and stored similarly to be used for extra-cellular enzyme tests.

The assay of enzyme activity was conducted by the difference between the results of the active enzyme extract and enzyme extract inactivated by autoclaving.

TABLE I

Nature of estimation	Enzymes	Substrate	Activity			
			<i>T. rubrum</i>		<i>T. mentagrophytes</i>	
			Intra-cellular	Extra-cellular	Intra-cellular	Extra-cellular
Qualitative and Quantitative	Lipase	Emulsified olive oil	+	+++	+	+++
	Butyrase	Ethylacetate solution	-	-	+	-
	Catalase	Hydrogen peroxide	+	-	+	+++
	Urease	Urea (1% sol.)	-	+	-	+
	Proteolytic enzyme	Peptone (2% sol.)	+	++	+	++
	Phosphorylase	Cori-ester	++	not done	+	not done
	Dehydrogenases	Iso-citric acid	+++	do.	++	do.
		$\alpha$ -keto glutaric acid	++	do.	++	do.
		Malic acid	+++	do.	++	do.
		Succinic acid	++	do.	++	do.
		Aspartic acid	+	do.	+	do.
		do.	+++	do.	+	do.
		Glutamic acid	+++	do.	+	do.
		Serine	++	do.	+	do.
	Deaminases	Alanine	+++	do.	+++	do.
		Leucine	+++	do.	++	do.
		Arginine	ppt.	do.	ppt.	do.
Qualitative	Amylase	Starch (5%)	+	+	+	+
	Invertase	Sucrose (1%)	+	+	+	+
	Raffinase	Raffinose (1%)	+	+	+	+
	Cellulase	Sterilised filter-paper	+	+	+	+
	Laccase	Hydroquinone (1% fresh sol.)	-	-	+	+
	Pectinase	Potato discs	+	+	+	+
	Tyrosinase	Tyrosin	-	-	-	-
	Rennase	Fresh milk	+	not done	+	not done
	Glycerophosphatase	Na- $\beta$ -glycerophosphate	+	do.	+	do.

+ Arbitrary unit expressing enzyme activity (for quantitative estimation).

+ Denotes presence of the enzyme (for qualitative estimation).

- Denotes absence of the enzyme.

The results of the experiments revealed the presence of enzymes as summarised in Table I.

It seems that the metabolic processes in dermatophytes may closely follow the pattern found in other parasitic micro-organisms. Detailed paper on these enzymes and their significance in metabolism will be published elsewhere.

Botany Department, S. N. DAS-GUPTA,  
Lucknow University, S. K. SHOME.  
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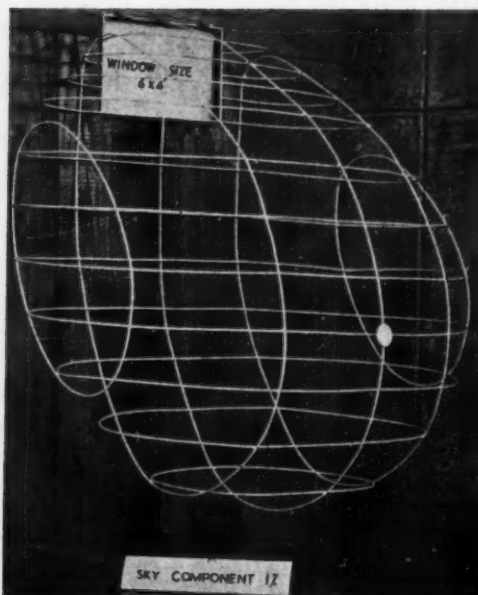
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### SKY-COMPONENT SURFACES

Sky-component surface is defined as a three-dimensional locus of points in front of a window where the sky-component retains a constant value. Such surfaces can be computed using sky-component tables.<sup>1</sup> The surfaces corresponding to 1 and 2% sky-components in the horizontal plane due to a 6' x 4' vertical window are shown reproduced in wire-mesh in the accompanying photographs.

These models show visually the variations in the penetration and area coverage for any sky-component percentage. For example, it is seen that the penetration and area coverages increase initially with increasing sill heights to maximum values, and thereafter decrease. None of the surfaces extend above the lintel level as no sky can be seen from points above that level. The sill height for maximum



penetration or maximum area coverage can be readily determined for any given value of the sky-component.

This note is published with the permission of the Director.

Central Building  
Research Institute,  
Roorkee, September 13, 1960.

T. N. SESHADRI.  
R. C. JAIN.

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#### POWDER CHROMATOGRAPHY FOR ESTIMATION OF CAROTENE IN THE FIELD

ALL the known methods for determining carotene can only be carried out in a laboratory. During our deficiency surveys we have felt the need of a technique for carotene assay which can be applied on the spot. Carotene is an essential nutrient for all classes of animals, but its biological activity is readily affected on storage by a number of natural factors, such as air, light, heat, etc. As such the practice of bringing biological materials from the field for examination in the laboratory may sometimes make it impossible to get a correct idea of the amount of carotene ingested by the animal. To

obviate this difficulty the present study was initiated.

Carotene in feeds was extracted by the method of Bacharach<sup>3</sup> using a mixture of 1:1 acetone and petroleum ether. The Waring Blendor homogenization suggested by Majumdar and Gupta,<sup>1</sup> although more convenient, was not considered suitable for use in the field. The petroleum ether extract free from traces of acetone was divided into aliquots. Column chromatography was applied to one and the other aliquot was shaken in a beaker with an amount of bonemeal powder (Mann<sup>2</sup>) equal to that used in the column. 5-7 g. of the powder was enough for this purpose. Xanthophylls and other non-carotenoid pigments were adsorbed in the bonemeal powder as efficiently as they were in the chromatogram. The pure carotene extract was then allowed to stand for half an hour and then decanted or filtered through a Whatman No. 40 filter-paper and carotene directly compared in a colorimeter. The results of duplicate determinations are set out in Table I.

The data in Table I show that powder chromatography with bonemeal is equally efficient for the purpose of determining total biologically active carotene as column chromatography and further, the method can be successfully employed in the field where no laboratory facilities are available. If however a separation into their

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Isomers is desired, column chromatography in a laboratory has to be applied.

TABLE I

Material used	Size of sample (g.)	Carotene $\mu\text{g./g.}$ fresh material		% Deviation
		Column chromatography	Powder chromatography	
1 Lucerne ( <i>Medicago sativa</i> )	1	53.58	54.69	+2.07
2 Dhub ( <i>Cynodon dactylon</i> )	2	(a) 112.50	(a) 114.14	-0.38
		(b) 110.70	(b) 108.20	
3 Lucerne (Another sample)	1	(a) 79.13	(a) 79.20	-0.12
		(b) 78.24	(b) 78.00	
4 Kulfa ( <i>Portulaca oleracea</i> )	2	(a) 20.70	(a) 22.05	+3.21
		(b) 21.60	(b) 21.60	
5 Cattle faeces*	20	(a) 19.44	(a) 19.44	-2.86
		(b) 19.62	(b) 18.50	
6 Cattle faeces (Another sample)	5	(a) 41.44	(a) 38.85	-5.61
		(b) 42.00	(b) 39.90	
7 Sheep faeces	5	(a) 84.00	(a) 89.10	+3.85
		(b) 85.56	(b) 87.00	

\* 7 g. of bonemeal powder was used for powder chromatography in this case. In all other cases 5 g. was used.

The authors desire to thank Shri P. G. Pande, Director, for his sustained encouragement.

Animal Nutrition Division, B. N. MAJUMDAR.  
Indian Veterinary Research B. N. GUPTA.

Institute, Izatnagar, U.P.,  
August 2, 1960.

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# ON THE OCCURRENCE OF A HETEROTRICHOUS CILIATE, *METOPUS SPIRALIS* SMITH, (PROTOZOA) IN INDIA

A FRESHWATER collection made in August 1959 from a pond at Sibpur, Howrah District (West Bengal), showed presence of a few small ciliates of three types which appeared to be of interest. However, specimens belonging to only one of the types were in sufficient numbers in the collection which are being dealt with here.

At the time of collection the pond was full with clear water and plenty of vegetation. Collections were made from different parts of

the pond. They were kept in specimen tubes in laboratory for a week. The type described here was encountered in drops pipetted from just above the settled sediment in the tubes. Individuals were isolated and observed in drops of natural medium. Isolated specimens on slides were killed by Lugol's iodine and then fixed with Schaudin's fixative. Haedenhain's Iron-Haematoxylin and Eosin were used for staining.

**Taxonomic Position.**—Class: Ciliata; Order: Spirotricha; Sub-order: Heterotricha; Family: Metopidae Kahl, 1927; Genus: *Metopus* Claparede and Lachmann, 1858.

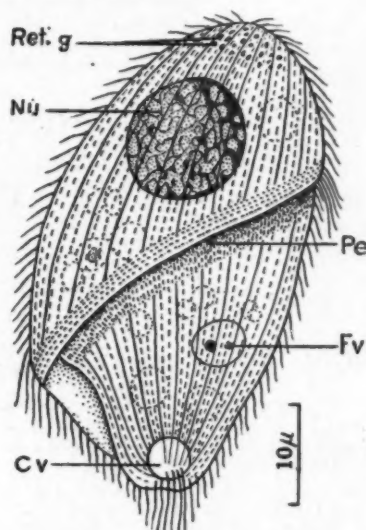


FIG. 1. *Metopus spiralis* Smith.

Cv—Contractile vacuole; Fv—Food vacuole; Nu—Nucleus; Pe—Peristome; Ref. g—Refractile granules.

On close examination the specimens are found to belong to the genus *Metopus* Kahl, 1927. Amongst all the species included under the genus so far, they show the closest resemblance to *Metopus spiralis*. However, they show slight variations, which are indicated in the brief description given below.

The body of the ciliate is roughly oval in shape, having the posterior portion ending in a blunt cone. It measures 48-59.5  $\mu$  in length and 25.5-36  $\mu$  in width. Body, in general, is transparent except for the anterior left where a few refractile granules are seen aggregated. The peristome is a spiral depression running diagonally from anterior left to the posterior



right side, thus rendering a spiral shape to the body. The portion near and just above the peristome is densely ciliated with long cilia. Ciliation is uniform in other parts of the body. Body is striated in a linear form.

The conspicuous round contractile vacuole is at the posterior end. Macronucleus is single, spherical, measuring  $12.5\mu$  in diameter and is placed at the anterior third. Micronucleus is single and is seen only in one specimen. It lies closely apposed to the macronucleus.

A review of literature reveals that no freshwater representative of the family Metopidae has been recorded from India so far. This is therefore the first record of this type. Two marine species of the family Metopidae were recorded by Ganapati in 1958.

I am grateful to Dr. M. L. Roonwal, Director, Zoological Survey of India, for his kind help and interest in my work. I am indebted to Dr. H. N. Ray for initiating me to the subject and to Dr. B. S. Chauhan for guidance.

Protozoology Section,  
Zoological Survey of India,  
Calcutta, May 7, 1960.

K. N. NAIR.

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#### M-CHROMOSOMES IN A PENTATOMID BUG, *SCOTINOPHARA* SP.

Of the Gymnocerata, the Coreidae and Lygaeidae (except Lygaea) are characterised by the presence of a special pair of chromosomes called the *m*-chromosomes.<sup>2-4</sup> These differ from the other autosomes in that they are smaller in size and are visible for the first time at the diplotene stage during meiosis as over-condensed bodies. Further they do not form any chiasma and undergo 'touch and go' pairing during the first meiotic division.

No such elements have so far been reported in the family Pentatomidae. A detailed account of the behaviour of such a pair in the pentatomid bug, *Scotinophara* sp.<sup>1</sup> is presented.

The spermatogonial metaphase (Fig. 1) in this species shows twelve elements, out of which three small chromosomes stand clearly marked from the remaining comparatively larger ones. From the fact that during metaphase II, the sex

chromosomes constitute a heteromorphic pseudo-bivalent, it becomes evident that one of these three small elements is a sex chromosome (X or Y), the other being morphologically indistinguishable from the larger elements. The other two small elements are the *m*-chromosomes.

The autosomal bivalents, when they reappear after the diffuse stage, are in the diplotene phase (Fig. 2). The nucleus at this stage reveals, in addition to the four autosomal bivalents and a lightly stained plasmosome, four highly condensed and darkly stained bodies. Of these, the two bipartite elements are unequal in size and represent the two sex chromosomes, X and Y, while the remaining two which lie independent of each other are the *m*-chromosomes.



FIGS. 1-6

Fig. 1. Spermatogonial metaphase (polar view). Fig. 2. Diplotene showing the separate *m*-chromosomes. Fig. 3. Metaphase I (polar view). Fig. 4. Early anaphase I showing precocious anaphase disjunction of *m*-chromosomes. Fig. 5. Metaphase II (polar view). Fig. 6. Metaphase II (side view).

The metaphase I (Fig. 3) shows seven elements. Of these, four are the autosomal bivalents, two are sex chromosomes and the remaining small one, the *m*-chromosome pair. The latter shows a precocious anaphase disjunction (Fig. 4). During metaphase II (Fig. 5) there are six elements seen, of which the smallest is the *m*-chromosome. The latter divides equationally during this division (Fig. 6).

The deviation in the diploid number of chromosomes of this species, from the type number ( $12 + XY$ ) of the family Pentatomidae as well as of its congeneric species, *Scotinophara horvathi* (Toshioka<sup>5</sup>), suggests a recent origin of the *m*-chromosomes in this species. Much importance may not, therefore, be attached to these *m*-chromosomes which are otherwise of a great phylogenetic significance in Heteroptera.<sup>3,4</sup>

I am indebted to Dr. G. P. Sharma, Professor and Head of the Department of Zoology,

Panjab University, for the necessary laboratory facilities and kind supervision.

Senior Research Scholar, SOHAN SINGH JANDE.  
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Department of Zoology, Panjab University,  
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**A NOTE ON THE LIFE-HISTORY OF  
MICROCEPHALOTHRIPI BREVIPALPIS  
(KARNY) (THYSANOPTERA,  
THRIPIDAE)**

The flower-thrips *Microcephalothrips brevipalpis* (Karny)<sup>1-3</sup> is a serious pest of most of the composite flowers. It causes premature drying and shedding of flowers. The condition is produced due to gregarious feeding by the larvae and adults. As a result of such feeding the flowers are desapped and ultimately get highly susceptible to fungal attacks, injured flowers turn papery and wilt very soon.

The adult thrips migrate from flower to flower and multiply, they consist of macropterous females, and both macropterous and micropterous males. Females are more numerous than males usually bearing the ratio of 5:1 in a single flower.

*Microcephalothrips brevipalpis* (Karny) reproduces sexually as well as parthenogenetically. Post-embryonic development occurs in four instars which include two larval instars, a prepupa and a pupa. Oviposition begins 72-96 hr. after emergence. Eggs are inserted only in the disc-florets, where they are usually studded at the base of the corolla between the lower ends of the stamens, or sometimes in any soft tissue of the flower whenever the infestation is heavy.

The eggs are small, subspherical and yellowish, with anterior end slightly narrowed. Eclosion from egg takes place in 72-80 hr. at 27°C. Each egg splits at its anterior end in a circular fashion and the first instar larva wriggles out of it gradually. The latter is translucent, whitish-yellow and bears conspicuous antennae. Third and fourth antennal joints are swollen and carry transverse striations. The second instar larva is longer and yellowish with slender antennae. It feeds gregariously and in nearly

three days it undergoes another moult to enter the prepupal stage.

Prepupa is sluggish. It has a swollen body with pinkish-yellow colour. The antennae are markedly contracted and swollen. It carries two pairs of wing-buds. At this stage feeding stops completely, and prepupa rests between the outer bracts of flower-heads or between the bases of two florets. Within twenty-four hours it moults into a quiescent pupa.

The pupa is robust and pinkish. Antennae are reflected over the head. The wing-buds are greatly lengthened. The sex of the pupa can be differentiated by size differences and also by chaetotaxy of 8th and 9th abdominal segments of male and female pupa. After 24-48 hr. the pupa gives rise to the imago.

There are several overlapping generations every year. The whole life-cycle of *Microcephalothrips brevipalpis* (Karny) from egg to imago is completed in 11-13 days. Fuller account will be published elsewhere.

My sincere thanks are due to Dr. H. S. Vishnoi for supervising the work, to Prof. M. L. Bhatia for extending research facilities and to Dr. T. N. Ananthakrishnan, Professor of Zoology, Loyola College, Madras, for the identification of the material and for making useful suggestions.

Zoology Department, USHA KUMARI JAGOTA,  
University of Delhi,  
Delhi-6, July 9, 1960.

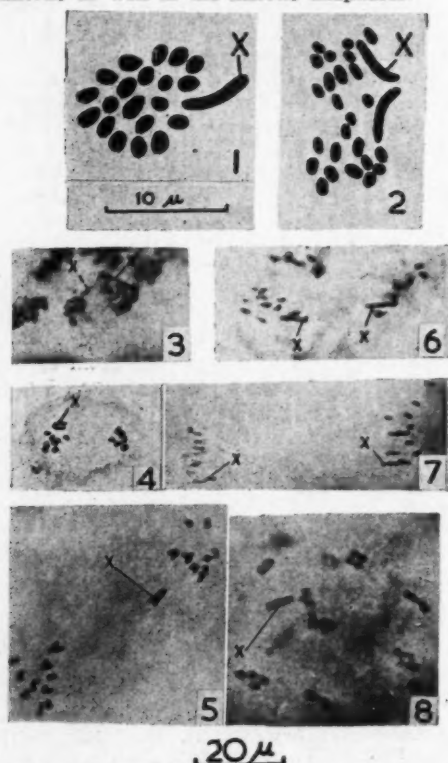
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**CENTROMERE IN THE SEX-CHROMOSOME OF THE MALES OF HYALOMMA AEGYPTIUM AND RHIPICEPHALUS SANGUINEUS (ACARINA: IXODIDAE)**

DUTT,<sup>1</sup> working on the chromosomes and male meiosis of *Hyalomma aegyptium* (cattle-tick) and *Rhipicephalus sanguineus* (dog-tick), described the diploid number of twenty-one chromosomes with XO-type of sex-determining mechanism in each. In both the species all the autosomes, according to him, are acrocentric, while the single X is metacentric with its two arms unequal. He has further observed that in *H. aegyptium* the metacentric X-chromosome with unequal arms is quite distinct even at the diplotene.

We have, on the other hand, observed that in both the species the X-chromosome is

undoubtedly acrocentric. Such a nature is clearly manifested by the localization of the active mobility at one of its terminals, during the mitotic as well as the meiotic anaphases.



FIGS. 1-8. Figs. 1, 2, 3, 4 and 6. *Hyalomma aegyptium*. 1, spermatogonial metaphase (polar view); 2 and 3, spermatogonial anaphases (showing the separating sex-chromosome and only some of the autosomes in Fig. 2); 4, anaphase I; 6, anaphase II. Figs. 5, 7 and 8. *Rhipicephalus sanguineus*. 5, anaphase I; 7, anaphase II; 8, diakinesis. Fig. 4 is from the sectioned material fixed in Sanfelice and stained with iron haematoxylin, while all the others are from permanent acetocarmine squashes. Figs. 1 and 2—camera lucida drawings, Figs. 3-8—photomicrographs.

Figure 1 shows the spermatogonial complement of *H. aegyptium* with twenty autosomes and a single large rod-like X-chromosome. During the spermatogonial anaphase the X-chromosome moves parallel to the spindle fibres, revealing the localization of the active mobility only at one end (Figs. 2 and 3). Figures 4 and 5 represent the anaphases of the first meiotic division in *H. aegyptium* and *R. sanguineus* respectively. In the former, the X-chromosome moves along with the autosomes, while in the

latter it lags behind them. All the elements, the autosomes as well as the sex-chromosome, appear V-shaped due to the precocious separation of the two chromatids of each chromosome at their distal ends. Their proximal ends which are actively mobile are, however, held together. During anaphase II (Figs. 6 and 7) in both the species, the X-chromosome again moves parallel to the spindle fibres.

A critical study of diakinesis (Fig. 8) also reveals the X-chromosome as precociously divided into the chromatids. The latter lie parallel and quite close to each other with a clear split running throughout their length excepting at one end where the centromere lies.

From the fact that the X-chromosome at the spermatogonial metaphase is slightly bent, Dutt<sup>1</sup> appears to have regarded it as metacentric with the two unequal segments on the sides of the bend, representing its unequal arms. It may, however, be pointed out that one or more elements, when distinctly larger than the remaining ones, generally show a varied type of bending, at the equatorial plane, which has no correlation whatsoever with the position of the centromere.<sup>2,3</sup> The localization of the active mobility at one end of the chromosome during mitotic as well as meiotic anaphases clearly reflects its acrocentric nature. Even the Figs. 4, 5, 9 and 10 given by Dutt<sup>1</sup> himself clearly reveal that the X-chromosome moves parallel to the spindle fibres during meiotic anaphases. During the anaphases of the first meiotic division the X-chromosome, exactly like the autosomes, appears V-shaped, which is doubtlessly due to the precocious separation of its chromatids at the distal end. Such a precocious separation of the chromatids in the otherwise acrocentric chromosomes has already been reported in spiders.<sup>4</sup>

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Panjab University,  
Chandigarh, August 2, 1960.

G. P. SHARMA,  
M. G. JONEJA.

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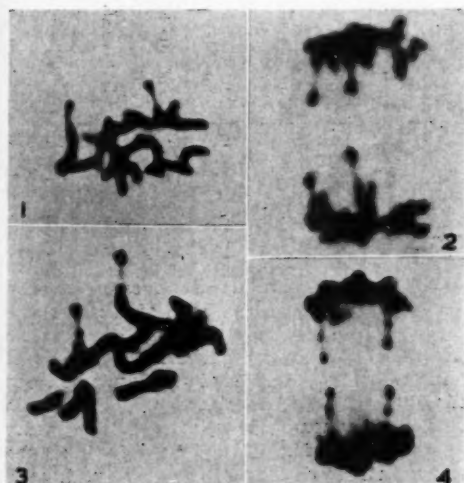
#### TANDEM SATELITES IN *CICER ARIETINUM* LINN.

THIRTY varieties of *Cicer arietinum* Linn. investigated by Iyengar<sup>1</sup> showed a uniform chromosome number of 16. While this confirmed Avudulov's<sup>2</sup> observations, it differed from the earlier reports<sup>3,4</sup> suggesting 14 as the chromo-

some number. Iyengar could not substantiate Dixit's<sup>5</sup> claim that while the "Desi" types had only 14 chromosomes, the "Kabuli" variety had 16. Thomas and Revell<sup>6</sup> confirmed Iyengar's findings as regards the chromosome number.

While Dombrowskaia-Slutskaia<sup>3</sup> described one pair of chromosomes as satellited, Iyengar described and figured two pairs. There is no record of the occurrence of tandem satellites. It is in this context that the observations recorded below are of interest.

The non-availability of seeds of pure strains necessitated a dependence on material purchased from the market. Root tips of 24-hr. germinated seeds fixed in acetic alcohol, hydrolysed in N HCl, were stained in bulk with Heidenhain's hæmatoxylin and squashed according to a technique devised in this laboratory (Marimuthu and Subramaniam, unpublished). The photos are from permanent preparations mounted in Canada balsam.



FIGS. 1-4. Figs. 1 and 3,  $\times$  ca. 2,300. Figs. 2 and 4,  $\times$  ca. 2,000.

The chromosome number is 16 and in general there is only a pair of satellited chromosomes. Figure 1 shows the satellites in metaphase and Fig. 2 in anaphase. The thickness of the satellite thread in the preparations is dependent on the pressure applied during squashing. What is interesting is that in some preparations the satellites showed a tandem condition. In some slides a gradation between the normal and the tandem condition was also observed. Figures 3 and 4 illustrate the tandem satellites in meta- and ana-phases respectively.

It has been suggested<sup>7</sup> that a tandem type can originate from a pair of satellited chromosomes by break and reunion at two loci. Srinath<sup>8</sup> reports that such changes may occur during anaphase of somatic mitosis. Though the paired tandem satellites in Figs. 3 and 4 cannot be interpreted in that manner the above suggestion is interesting in the context of the rare variations in the morphology of the satellites in the same root.

Cytogenetics Lab., Miss G. MEENAKSHI.  
Dept. of Biochemistry, M. K. SUBRAMANIAM.  
Indian Institute of Science,  
Bangalore-12, September 23, 1960.

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#### NEW RECORDS OF BARNACLES FROM BOMBAY SHORES

DURING a faunistic survey of the shore organisms of Bombay (West Coast of India) in 1956, nine forms of barnacles were collected. Of these, three, viz., *Balanus amphitrite hawaiiensis* Broch, *Balanus amphitrite malayensis* Hoek and *Chthamalus challengerii* Hoek, have been found to be new records for India.

Specimens of *Balanus amphitrite hawaiiensis* are found attached to rocks in the mid-littoral zone in different localities. Nilsson-Cantell<sup>3</sup> described a specimen from Persian Gulf, attached to the crab, *Schizophrys aspera* (Milne-Edwards). Previously this subspecies was recorded from Malay Archipelago and West Pacific. This record of *B. amphitrite hawaiiensis* from India is of special interest in view of its occurrence in such widely separated areas as Malay Archipelago and Persian Gulf.

*Balanus amphitrite malayensis* was first described by Hoek<sup>2</sup> in 1913 from specimens found attached to small sticks or stems at depths of 13-40 m. in Malay Archipelago. In Bombay also, a few forms of this subspecies were found attached to and imbedded in Gorgonians in the sublittoral region.

*Chthamalus challengerii* is very plentiful on the high rocks in the wave-exposed localities of Bombay. It has been previously reported from the Red Sea, Colombo, Malay Archipelago and Japan.



In addition, *Tetracrita purpurascens* (Woods) has been recorded for the first time from the West Coast of India. It is a zone-forming species, occurring attached to rocks in the lower littoral zone of Breach Candy, an exposed locality. The only previous record of *T. purpurascens* in India is by Daniel<sup>1</sup> from Madras.

A full account of the littoral cirrheps of Bombay will be published elsewhere.

Department of Zoology, Y. M. BHATT.  
Institute of Science, D. V. BAL.  
Bombay-1, September 8, 1960.

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#### INCIDENCE OF PINK BOLLWORM (*PLATYEDRA GOSSYPIELLA* SAUND.) ON COTTON IN RAJASTHAN

PINK bollworm, *Platyedra gossypiella* Saund., is a major pest of cotton, especially on American varieties, in Rajasthan. Some preliminary observations were made during 1959-60 cotton season which happened to be an epidemic year for these worms to experimentally assess the incidence of this pest on cotton. As reported earlier<sup>1</sup> the peak infestation period of this pest occurs sometime during December. Observations were, hence, made for the estimation of incidence in the bolls, seed cotton (Kapas) and ginned cotton-seed which are recorded below:

(a) In bolls.—In the fields of cotton experimental station, 8 weekly observations were made to estimate the average infestation in the bolls commencing from December 1, 1959, immediately after the first picking in an 1.25 acre plot. At random 5 plants in each row were examined for incidence in the bolls and the results are summarised in Table I.

TABLE I

Pink bollworm infestation in the bolls after first picking in the standing crop

Sl. No.	Locality and variety	No. of observations	No. of bolls examined	No. of bolls attached	% bolls attached		
					Max.	Min.	Average
1	Udaipur C. Indor	8	930	714	83.3	63.3	80.25

(b) In seed cotton (Kapas).—The samples were analysed on locule basis for recording the percentage of yellow cotton, caused by the pink bollworms. The observations are given in Table II.

TABLE II  
Pink bollworm infestation in seed cotton (Kapas) during second picking

Sl. No.	Locality and variety	No. of locules examined	No. of locules with yellow cotton	% of locules with yellow cotton
1	Udaipur C. Indore	1 813	240	29.50
2	Udaipur LL 54 ..	222	42	18.92
3	Udaipur M.48-4 ..	163	30	12.30

(c) In ginned cotton-seed.—For this purpose seed samples were collected from five important ginning factories in Rajasthan which were subjected to similar examination and analysis. The results of these observations are given in Table III.

TABLE III  
Incidence of pink bollworm in the ginned cotton-seed

Sl. No.	Ginning factory and variety	No. of seeds examined	No. of seeds infested	% of attack	Double seeds	% double seeds harbouring pink bollworm
1	Sriganganagar 320 F	400	21	5.25	7	1.25
2	Kapasin C. Indore	430	13	3.25	8	2.00
3	Tonk C.520 ..	500	22	4.40	4	0.80
4	Jhalawar Virnar	500	22	4.40	4	0.80
5	Sriganganagar G-1	700	29	4.14	10	1.43

From these observations it is seen that the average infestation in the bolls of the standing crop after 1st picking was 80.25%. The lint was spoiled by the pink bollworms to the extent of infestation of 12-30% of the locules having yellow cotton. The incidence of this pest in the ginned cotton-seed collected from ginning factories varied from 3.25% to 5.25% on the basis of total seeds found infested by pink bollworm and from 0.80% to 2.00% on the basis of double seeds harbouring pink bollworms in them.

The work was done in a scheme financed by the Indian Cotton Committee and the author is indebted to Shri Samarth Raj Mathur, Director of Agriculture, Rajasthan, Jaipur, for providing facilities and encouragement for this work.

Cotton Pests Control Scheme, S. P. BHATNAGAR, Dept. of Agriculture, Rajasthan, Udaipur, June 21, 1960.

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# A NOTE ON THE CONTROL OF THE FIELD RAT, *NESOKIA INDICA* (BLYTH)

AMONG the field rats found in gardens and fields *Nesokia indica* is the most common in many localities in Delhi, causing considerable destruction to lawns and cultivated plants in kitchen gardens. It is a serious pest in the experimental fields at the Indian Agricultural Research Institute. Experience in the past had shown that poison gassing did not give satisfactory results against this field rat and so a close study was made on its habits during the active season from December to February. The observations made by the present authors on its habits and the results of preliminary trials with cyanogas are incorporated in this note.

*N. indica* is a medium-sized rat with round ears covered with fine hair. Its presence in a locality can easily be made out by the fresh heaps of earth (h.e.) covering the entrance to burrows. The breeding season in Delhi is from December to February. It is nocturnal in habit,

possible emergency shelters. When a rat burrow is cut open, it is closed within about half an hour if a rat is present in the burrow.

In the course of preliminary tests with cyanogas it was observed that the usual method of gassing was not quite effective in killing *N. indica*. When cyanogas was pumped in after closing the exit holes, the rat invariably escaped out by making new holes, or sometimes they were found to take refuge in one of the emergency shelters (s.b.e.) which was situated deep down from the main burrow. Based on the knowledge of its habits, a fairly satisfactory method of cyanogassing was developed. The present method consisted of confining the rat within a distance of about 10 feet of the burrow (A). This was accomplished by breaking the burrow at some points along the bund; the breaking of the burrow was done in such a way that a clear gap (C) of about 6 to 8 inches was left between the cut-ends. If the opened ends (e) of the burrow are found blocked with

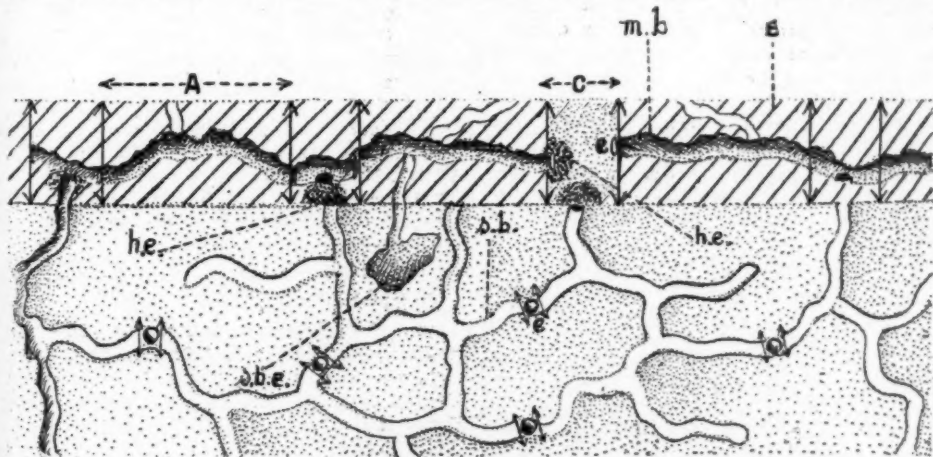


FIG. 1. Diagrammatic representation of the subterranean burrow of *Nesokia indica*.

rarely seen outside its burrow during the day. It generally inhabits bunds (B) of fields and lawns, feeding on roots, grasses and various grains and seeds. The main burrow (m.b.) runs along bunds in a more or less zig-zag way, about 4 to 9 inches below the surface, and with a number of secondary burrows (s.b.). The main and secondary burrows are interconnected. Some of the secondary ones are situated deep and end blindly in a cell (s.b.e.) These blind alleys are sometimes found about 20 inches below the surface of the ground and they serve as nests for the litters and also as

fresh earth within about half an hour, there is a definite indication that the rat is present within. In this way the rats are located one by one and cyanogas is pumped in from one end after closing the other. The present method had proved quite effective in the control of the common field rat in the experimental fields at I.A.R.I., New Delhi, and is quite economical as there is no wastage of cyanogas.

The problem of rats is likely to assume added significance in the near future in view of the fact that large quantities of food-grain are to be imported shortly from abroad and stored in our

country. Hence there is an urgent need to carry out intensive work on the biology and control of different species and races of rats met with in our homes and fields.

Our grateful thanks are due to Dr. E. S. Narayanan, Head of the Division of Entomology, and Dr. B. P. Pal, Director, for their keen interest in this problem. Our thanks are also due to the members of the University Department of Zoology, Delhi, for their assistance in the identification of rats.

Division of Entomology, T. V. VENKATRAMAN.  
I.A.R.I., New Delhi-12, JOGINDER LAL.  
June 24, 1960.

### SOME UNRECORDED DISEASES OF SORGHUM AND MAIZE FROM INDIA

THIS paper gives a brief description of two diseases of sorghum and one of maize which have not so far been recorded in India. The fact that we have been observing the sporadic cases of these diseases for the last several years indicates that these are not recent introductions. During Kharif season of 1959, these diseases were found to be causing appreciable damage in certain parts of the country. The specimens have been deposited in the Herbarium Cryptogammæ Indiæ Orientalis, New Delhi, and indicated by H.C.I.O. numbers in the text.

1. *Helminthosporium sorghicola* Lefebvre and Sherwin, in *Mycologia*, 1948, 40, 708-18 (Fig. a, b).



FIG. 1. *Helminthosporium sorghicola*. (a) Conidia,  $\times 300$ . (b) Conidiophores,  $\times 300$ . *Ascochyta sorghina*. (c) Pycnidiospores,  $\times 360$ .

The disease produces well-defined tan-coloured irregular to somewhat elliptic spots measuring  $5-15 \times 4-6$  mm. size, which assume an olivaceous tinge due to dense sporulation under moist conditions.

The conidiophores arise singly or rarely in groups of two or three, typically simple, olive brown, broadest at the base measuring  $150-250 \times 5-10 \mu$ , geniculate; conidia olive-brown,

$50-90 \times 16-20 \mu$ , usually curved, widest near the middle, tapering slightly towards rounded ends, 3-8 septate, peripheral wall thin but thickens with age, hilum moderately broad, not conspicuous.

On *Sorghum vulgare* L., Kota (Rajasthan), 14-9-1959 (Rockefeller Staff), \* H.C.I.O. No. 26611.

This is quite distinct from *Helminthosporium turcicum* Pass. which is very common on maize and is also recorded on this host from this country. The spores in the case of *H. turcicum* are characterised by the protruding hilum thus making the basal cell appear as conical.

2. *Ascochyta sorghina* Sacc. in *Michelia*, 1878, 1, 167 (Fig. c).

The disease is characterised by linear straw-coloured spots having purple to drab margin, on lower leaves. The spots coalesce to involve a bigger area and become studded with black dot-like subseriate to aggregated pycnidia, which give a rough appearance to the leaf surface.

The pycnidia are subglobose, rather depressed, innate erumpent, mostly  $150-200 \times 80-120 \mu$  in size; pycnosporos are oblong ellipsoid, 1-septate or rarely 2-septate, hyaline and measure  $18-22 \times 6-8 \mu$ .

On leaves of *Sorghum vulgare* L., Kota (Rajasthan), 14-9-1959 (Rockefeller Staff), H.C.I.O. No. 26600.

This species differs from *Ascochyta sorghina* Sacc., also recorded on this host from India, in having much broader spores.

3. *Cochliobolus heterostrophus* Drechsler, in *Phytopath.*, 1934, 24, 953-83.

Syn. *Ophiobolus heterostrophus* Drechsler, in *Jour. Agr. Research*, 1925, 31, 701-26.

*Helminthosporium maydis* Nishikado and Miyake in *Ber. Ohara Inst. Landw. Forsp. Kuraschiki*, 1926, 3, 221-26.

The fungus produces small, buff to brown-coloured elongated spots, which are scattered throughout the leaf lamina and are irregular in outline being vein limited and measure 2 mm.-2 cm. long and 4-8 mm. in breadth. Later these turn dirty straw-coloured due to the formation of conidia and conidiophores.

The conidiophores arise singly or in groups of 2-3 from the immersed mycelium in the host tissues, usually through the stomata. They are typically simple, light to dark-brown or olivaceous,  $90-200 \times 10-12 \mu$ , thick-walled with 2-3 geniculations. The conidia are curved, occasionally straight, widest at just or below the middle, tapering evenly to the rounded ends, wall thin and not constricted; hilum inconspic-

ous and included in the basal contour, light olivaceous,  $35-110 \times (9)-11-(16) \mu$  with 5-10 septa. Germination bipolar.

On leaves of *Zea mays* L., Maldah (West Bengal), 4-8-1905, H.C.I.O. No. 26839.

The ascigerous stage of this fungus has not been observed so far in India. The present determination is based on characters of conidial stage. According to International Rules of Nomenclature, only one name should be applied to one species, therefore the name applied to perfect stage has been preferred.

The disease is rare and occasionally met with. Although from examination of herbarium specimens, it appears that the disease has been present in our country for a long time, it has escaped notice due to its rather inconspicuous nature. Lately some exotic varieties have been introduced under the hybrid maize programme, and the disease was found to be occurring fairly extensively on some of the lines.

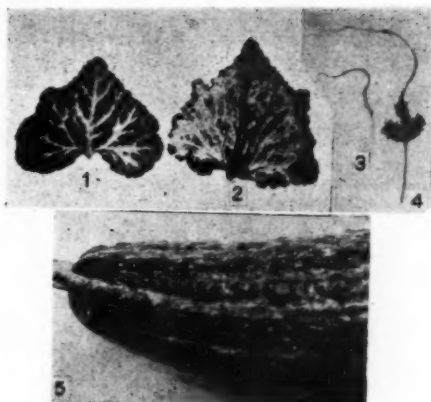
Sincere thanks are due to Dr. R. S. Vasudeva, for his keen interest, helpful criticism and encouragement. We are also indebted to Dr. K. O. Rachie, Sorghum Specialist, Rockefeller Foundation, for supplying the diseased material.

Division of Mycology and  
Plant Pathology,  
Indian Agric. Res. Inst.,  
New Delhi-12, April 18, 1960.

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#### DETECTION OF WATER-MELON MOSAIC VIRUS IN UTTAR PRADESH

DURING 1957 and in subsequent years, vegetable marrow (*Cucurbita pepo* L.) crop grown in the vicinity of Naini Tal have been severely damaged by a mosaic disease. The symptoms on diseased plants appear as distinct vein-clearing (Fig. 1) and vary from a coarse pattern of mosaic to a diffuse pattern where there is no clear demarcation between dark and light green areas. Generally plants may also bear leaves with distinct mottle showing vein-banding, where the bands of darker areas are seen associated with the major veins (Fig. 2). The leaves show severe distortion, malformation and extreme reduction of lamina. Generally the leaf apices get elongated into thread-like structures having the so-called 'shoe-string' appearance (Figs. 3 and 4). Affected plants become very weak and lose their vigour. Such plants bear very few fruits which are slightly distorted, smaller in size and have a rough surface (Fig. 5).



FIGS. 1-5. Fig. 1. Water-melon mosaic virus on vegetable marrow showing clearing of the veins. Fig. 2. Water-melon mosaic virus on vegetable marrow showing mosaic symptoms and bands of darker areas associated with major veins. Figs. 3-4. Extreme reduction of lamina of infected vegetable marrow leaves. Fig. 5. Portion of an infected fruit of vegetable marrow showing rough surface.

The virus is sap-transmissible and the host range is limited to cucurbitaceous plants only. It has a thermal inactivation point between 55 and 60°C.; dilution end point of 1:10,000 and remains infective *in vitro* for a period up to 8-10 days at 20-21°C. The virus is transmitted by *Aphis gossypii* Glove. and *Myzus persicae* Sulz., and is of non-persistent type. 0.36% seeds from diseased plants have been found to carry the virus.

The present virus differs from other cucurbit viruses so far reported from India<sup>1-3</sup> in its physical properties and in its ability to be transmitted by aphids. It is also unable to produce infection in *Momordica charantia* L. It differs from *Cucumis Virus 2* reported by Ainsworth<sup>4</sup> in physical properties and in its ability to infect vegetable marrow. In its limited host range it differs from some strains of water-melon mosaic virus recently reported by Grogan *et al.*<sup>5</sup>

The host range, physical properties and insect transmission of the virus from vegetable marrow resemble the water-melon mosaic virus reported by Anderson<sup>6,7</sup> and put in "Melon mosaic group" constituted by Lindberg *et al.*<sup>3</sup>

In addition to *Cucurbita pepo*, the other plants found naturally infected with the virus include *Cyclanthera pedata* Schrad.; *Cucurbita maxima* Duche. and *Cucumis sativus* L. This is the first record of water-melon mosaic virus in this country.

The authors are grateful to the Scientific Research Committee, Uttar Pradesh, for the financial assistance during the course of present investigations.

Department of Botany,  
Gorakhpur University,  
Gorakhpur (U.P.),  
May 16, 1960.

K. S. BHARGAVA.  
R. D. JOSHI.

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#### OPHIOGLOSSUM FROM THE PLAINS OF EASTERN U.P.

THE purpose of this paper is to record the occurrence of *Ophioglossum vulgatum* Linn. in wild state in Gorakhpur and *Ophioglossum capense* Sw. from Varanasi.

*Ophioglossum vulgatum* has been observed growing in isolated and widely separated spots in the Kusmi forest (26° 40' N., 83° 25' E.), 253 ft. above sea-level, seven miles east of Gorakhpur city wherefrom the occurrence of another member of the order Ophioglossales, viz., *Helminthostachys zeylanica* Hook. has been reported earlier (Roy and Kumar, 1959). *Ophioglossum vulgatum*, however, does not grow on the soil of the same composition as that on which *Helminthostachys* thrives. The former is found on more coarse and sandy soil which is naturally drier, the pH of the soil being 8.5.

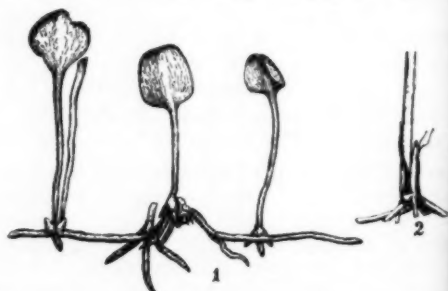
The plants are robust, usually 9-10" long from the base of the stem to the apex of the strobilus. The fronds vary in dimensions having a sterile blade, 1.5-2.0" in length and 1.0-1.5" in breadth with a shaft, 3-4" long. The leaves are dark green in colour, slightly fleshy and ovate at the base with an acute apex. The venation is reticulate without any midrib, but veins near the centre are more conspicuous.

The rhizome is erect and elongated measuring 0.7" in length, and bearing usually one frond per stem per season, but 2-3 fronds spirally inserted on the stem are also not uncommon. Each frond shows the development of the fertile spike from the juncture of the sterile blade and the shaft. The strobilus is 1.0-1.5" in length

with a long peduncle measuring 4.5". There are about 50-52 embedded sporangia on each strobilus and arranged in two rows. The lower part of the rhizome is occupied by long, stout and spirally arranged roots.

Cross-sections of the stem at the base show a protostele in which a medulla makes its appearance a few millimeters above; the latter enlarges in diameter so that the stele assumes the shape of a funnel, gradually becoming ectophloic siphonostele. Further up the central strand is intersected at various places by widely overlapping leaf gaps resulting in a dictyostelic condition with the formation of 4-5 meristemes of different sizes. The xylem of the meristemes is endarch. The rachis shows four meristemes at the base and nine at the upper region of which six enter the sterile blade of the leaf and three the stalk of the fertile spike. In the latter these three by radial splitting produce four, then five and six meristemes surrounded by loose spongy parenchyma with big air-chambers. The epidermis is highly cutinized with slightly sunken stomata. The root is monarch with some endophytic organism in the cells of the cortex and is devoid of root hairs.

The most interesting feature of the plant is its rapid mode of vegetative propagation by the formation of root buds (Fig. 1). Similar



FIGS. 1-2. Fig. 1. *Ophioglossum vulgatum*, young plants sprouting from root buds.  $\times 2/3$ . Fig. 2. *Ophioglossum capense*, erect rhizome with lower part of rachis, the former showing conspicuous sheaths.,  $\times 2/3$ .

instances were noted by Bower (1908). Efforts were made to discover the gametophyte in a patch of a luxurious growth of the plant, the population consisting of both young as well as old specimens. Young sporophytes attached to small, cylindrical, brownish, underground and prostrate structures, which externally appeared to be gametophytes, were examined, but in all the instances they turned out to be fragments of roots of various sizes that bore root buds which developed and produced the sporophytes. In



some plants, the long roots are found to produce active buds at different places. Thus the reproduction of the plant is effected chiefly by vegetative means.

The other species, viz., *Ophioglossum capense* Sw. was found growing among the grasses in the University campus at Varanasi (25° 22' N., 83° 80' E.), 267 ft. above sea-level. The plant produces fronds every year in the months of August and September; they remain hardly for a couple of months only, after which the plants are survived by the rhizomes and probably propagated by root buds. The external features of the aerial parts of this plant closely resemble those of *O. vulgatum* described above, but the erect rhizome shows conspicuous brown sheaths (Fig. 2) measuring 0.2-0.5" in length, with a flattened base and narrow drawn out apical part. These two species closely resemble the description given by Chakravarty (1951). The vascular construction of the former is principally the same as that of the latter.

Thanks are due to Prof. K. S. Bhargava for facilities and encouragement.

Botany Department,  
Gorakhpur University,  
Gorakhpur, May 16, 1960.

S. GANGULI.  
S. K. ROY.

## OCCURRENCE OF PERFECT STAGE OF APPLE SCAB PATHOGEN IN INDIA

Scab of apples caused by *Venturia inaequalis* (CKe) Wint is a common disease in Kashmir Valley. The disease mostly affects foliage and fruits and appears conspicuously during the months of July to September. *Fusicladium dendriticum* (Wallr.) Fuckel the conidial stage causing scab of apples in Northern India and Kashmir has been recorded earlier by Pushkar Nath.<sup>1</sup> This stage has been found belonging to *Spiloea pomi* Fr.<sup>2</sup> subsequently. Perfect stage on the overwintered apple leaves was collected during April, 1960, from apple orchards and is being reported here for the first time from India. A brief description of the local collection is presented in this note.

Perithecia appear as small black pimples embedded in the leaf tissue opening by a short beak. They are spherical 100 to 150  $\mu$  in diameter, Ostiolate, Ostiole being surrounded by several single-celled bristles. The wall of

perithecia is composed of brownish cells two to five layers in thickness. Asci arise from the base of perithecium and are fifty or more in number. Both young and mature asci are found within the same perithecium. They are slightly spatulate in form 50 to 75  $\mu$  by 8 to 12  $\mu$  in size.

Each ascus contains eight ascospores which are arranged in a single row in the upper part but in two rows in the lower portion. The ascospores are unevenly two-celled, the upper smaller and the lower bigger. They are hyaline to start with, but later light-olive brown in colour and measure 10-15  $\mu$  by 4-6  $\mu$ .

The specimens have been deposited in Herbarium Crystogammæ Indiæ Orientalis, New-Delhi.

Mycology Section,  
Agricultural Research Station,  
Lalmandi, Srinagar (Kashmir),  
August 1, 1960.

T. N. KAUL.

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## CYTOLOGICAL OBSERVATIONS ON THE EAST HIMALAYAN MEMBERS OF ASPLENIUM LINN.

DURING the last decade the fern genus *Asplenium* Linn. has been cytologically worked out from Europe,<sup>1-6</sup> North America,<sup>7-13</sup> Ceylon,<sup>14,16</sup> Madeira,<sup>1,16</sup> Malaya<sup>15</sup> and New Zealand.<sup>17</sup> But from India information about chromosome numbers of only 6 species is available.<sup>18-19</sup> Keeping in view the fact that the fern flora of the Eastern Himalayas is similar to that of Burma, Malaya and China (Yunan Province) and that many species are endemic to the Indo-Malayan region, cytological studies on the genus from Darjeeling-Sikkim Himalayas were undertaken during the years 1955-1958. When compared with Western Himalayas, the Eastern region is quite rich in variety as well as in number of ferns. Out of a total of 26 species of *Asplenium* from Northern India,<sup>20</sup> as many as 22 are present in the Eastern Himalayas.

In the present report 17 clear-cut species and 7 varieties consisting of 30 cytological entities (except for 2, all unworked so far) have been investigated following the usual acetocarmine squash-technique. Only meiotic studies have been made. The material has been collected between 500 and 10,000 ft. altitude from different places in Darjeeling District and Sikkim State. If the individual produces 64 normal and apparently viable spores, it has been scored



TABLE I  
Showing results for various species of *Asplenium*

No.	Name of the species	Locality*	Meiotic chromosome number	Polyploidy	Reproduction
1	<i>A. bullatum</i> Wall.	.. 18	$n=72$	Tetraploid	Sexual
2	<i>A. crinicaule</i> Hance	.. 16	$n=72$	"	"
3	<i>A. ensiforme</i> Wall.	.. 3, 5, 6, 7, 8, 9, 19, 23	$n=72$	"	"
4	<i>A. falcatum</i> Lam.	.. 2	$n=72$	"	"
5	<i>A. finlaysonianum</i> Wall.	.. 11, 12	$n=72$	"	"
6	<i>A. griffithianum</i> Hook.	.. 14	$2n=72$ ( $20_{II}+14_I$ )	Diploid hybrid	Sterile
7	<i>A. laciniatum</i> Don (type species)	4, 5, 15, 16	$n=72$	Tetraploid	Sexual
	var. <i>sub-integrifolia</i> Hook	.. 4, 5, 20	$n=72$	"	"
	var. <i>acutipinna</i> Bir	.. 5, 15	$n=72$	"	"
	X var. <i>sub-integrifolia</i> Hook.	.. 5	$2n=144$ ( $68_{II}+28_I$ )	Tetraploid hybrid	Sterile
8	<i>A. macrophyllum</i> Sw.	.. 2	$n=72$	Tetraploid	Sexual
9	<i>A. nidus</i> Linn. (type species)	1, 3, 10-13	$n=72$	"	"
	var. <i>phyllitidis</i> (Don) Bir	.. 3	$n=72$	"	"
	var. <i>acutifolia</i> Bir	.. 12	$n=72$	"	"
10	<i>A. nitidum</i> Sw. var. <i>obtusum</i> Sw.	12	$n=72$	"	"
11	<i>A. normale</i> Don	.. 5, 17	$n=72$	"	"
12	<i>A. paucivenosum</i> (Ching.) Copel.	(a) .. 9 (b) .. 6, 24	$n=72$ $n=144$	Octoploid Tetraploid	"
13	<i>A. planicaule</i> Wall. (type species)	.. 3, 5, 6, 16, 19, 20	$n=72$	Tetraploid	"
	var. <i>obtusum</i> Bir	.. 4, 5	$n=72$	"	"
14	<i>A. pellucidum</i> Lam.	14, 17	$n=72$	"	"
	var. <i>sikkimensis</i> Bir	.. 3	$n=36$	Diploid	"
15	<i>A. tenuifolium</i> Don	.. 4, 5, 22	$n=40$	"	"
16	<i>A. unilaterale</i> Lam.	.. 3	(Fig. 1) $2n=76$	Diploid hybrid	Sterile
	X <i>A. unilaterale</i> Lam.	.. 3	(76, Fig. 2) $2n=112$ ( $36_{II}+40_I$ )	Triploid hybrid	"
	var. <i>delicatulum</i> Par.	.. 6	$n=40$	Diploid	Sexual
	var. <i>udum</i> Atk.	.. 6	$n=40$	"	"
	X var. <i>udum</i> Atk.	.. 6	$2n=120$ ( $6_{III}+31_{II}+40_I$ )	Triploid hybrid	Sterile
17	<i>A. varians</i> Hook. et Grev. (a)	21	$n=36$	Diploid	Sexual
	(b)	24	$n=72$	Tetraploid	"

\* Key to the localities :

(a) DARJEELING DISTRICT :

	ft.
1 Teesta	.. 500
2 Teesta-Siliguri road	.. 500
3 Lebong Forest	.. 5,000
4 Rangaroon Forest	.. 5,000
5 Birch Hill	.. 7,000
6 Senchal Forest	.. 8,000
7 Sukhiapokhri	.. 8,200
8 Kalpokhri	.. 10,000
9 Tonglu	.. 10,000

(b) SIKKIM STATE :

10 Rangpo	.. 950
11 Andheri Khola	.. 2,000

12 Dickchu	.. 2,010
13 Pakyong road	.. 3,000
14 Dickchu-Singhik road	.. 3,500
15 Mangan	.. 4,000
16 Singhik	.. 4,400
17 Gangtok-Dickchu road	.. 4,500
18 Toong	.. 4,900
19 Chungthang	.. 5,100
20 Gangtok	.. 5,600
21 Chungthang-Lachen road	.. 7,000
22 Lachen	.. 8,800
23 Karponang	.. 9,500
24 Lachen valley	.. 10,000

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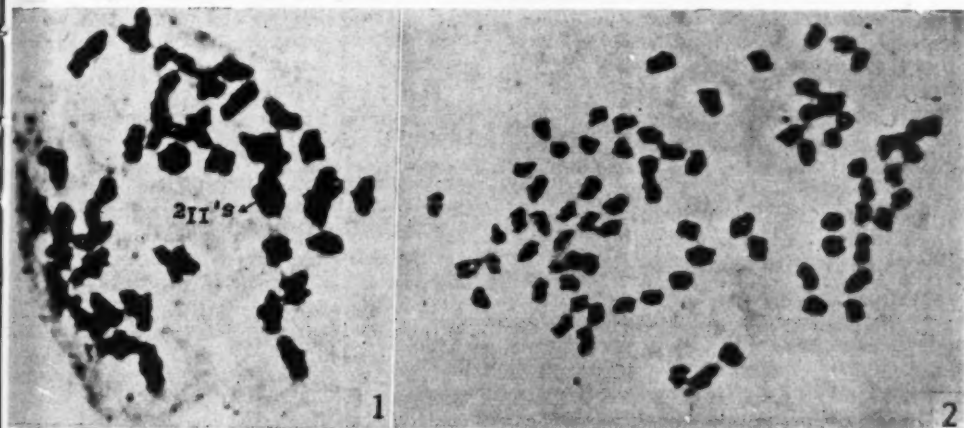
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as sexual. In case of hybrids out of the many cells examined, analysis for only one is given. The observations are presented in Table I.

suggestions. Thanks are also due to Dr. T. N. Khoshoo for helpful criticism and to Mr. R. S. Pathania for photomicrographs.



FIGS. 1-2. Fig. 1. A spore mother cell of *Asplenium unilaterale* Lam. showing 40 bivalents at late diakinesis,  $\times 2,100$ . Fig. 2. A spore mother cell of *X A. unilaterale* Lam. showing 76 univalents at late diakinesis. This is a total asynaptic form,  $\times 1,800$ .

A detailed account of these observations involving all aspects will be published in due course. However, at present it may be pointed out that the incidence of polyploidy and hybridization in this genus is quite high and evidently it shows that the genus is in an active state of evolution. On comparison of the cytological results of *Asplenium* from the Himalayas with those from Ceylon<sup>16</sup> and New Zealand<sup>17</sup> it is clear that the grade of polyploidy is much lower in this region.

The most interesting features of the present investigation are: firstly, in strong contrast to other species of the genus with  $x=36$ , *A. unilaterale* is based on  $x=40$ , and secondly, two dibasic natural hybrids (diploid and triploid) have been detected in *A. unilaterale* 'species complex'.

Furthermore, the two basic numbers ( $x=36$  and 40) have been woven together to give rise to many forms with  $n=40$ ,  $76 (36+40)/2$ ,  $112 (72+40)/2$  and  $120/2$ . To the writer's knowledge such a series of forms has not been discovered so far in any species or 'species complex' in ferns.

I am deeply indebted to Prof. P. N. Mehra for encouragement, kind guidance and valuable

Botany Department,  
Panjab University,  
Chandigarh-3, May 30, 1960.

S. S. Bm.

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## REVIEWS

**Dover Books : A Source Book in Mathematics.**  
By David Eugene Smith, 1959. Vol. I :  
Pp. 306, Vol. II : Pp. 395. Price \$1.85 each.

These volumes present, in English translation, the great discoveries in mathematics from the Renaissance to the end of the 19th century. One is able to read the original writings of mathematicians like Newton, Leibniz, Gauss, Reimann and others, exactly as their articles appeared for the first time.

In Volume I, the field of number is covered in 24 articles which trace developments from the first steps in printed arithmetic, through selected number systems to the early phases of modern number theory. We thus here read the writings of various mathematicians on different topics, e.g., Dedekind on imaginary numbers, Euler on  $e$ , Gauss on number congruence, etc. There are besides 18 articles on algebra by Fermat, John Wallis, Newton, Leibniz, Abel and Galois.

Volume II contains thirty-six articles on geometry which cover the development of the subject for over five hundred years. We here read the writings of geometers like Lobachevsky, Bolyai, Reimann and others. The field of probability is covered by several articles by Fermat, Pascal, Chebyshev and Laplace. The development of the calculus, function theory and quaternions is covered from early sources of the calculus to important advances relating to the commutative law in quaternions.

Each article is preceded by a biographical-historical introduction, and most articles besides contain portraits of their authors. There is no better source of inspiration for a scientific worker than the biographies and the original writings of the great Masters, and these two volumes will therefore offer delightful reading to all mathematicians. Some mathematicians composed verses too, and here we quote one by Bernoulli on infinite series.

"Even as the finite encloses an infinite series  
And in the unlimited limits appear,  
So the soul of immensity dwells in minutia  
And in narrowest limits no limits inhere,  
What joy to discern the minute in infinity!  
The vast to perceive in the small, what divinity!"

V.

**Semiconductors.** By R. A. Smith. (Cambridge University Press), 1959. Pp. 494. Price 65 sh.

In recent years the properties of the class of substances known as semiconductors have predominated the literature on solid state physics. Because of their unique properties, semiconductors have revolutionised the electronic industry. They are used as rectifiers, transistors replacing conventional valves, photoelectric cells, as infra-red detectors and as thermopiles and non-linear elements.

The matter under review has been compiled by the author out of a course of lectures on the physics of semiconductors, delivered by him at the Department of Engineering, University of Edinburgh. The material presented in the book appears under twelve chapter headings: (1) The Elementary Properties of Semiconductors; (2) Energy Levels in Crystalline Solids; (3) Impurities and Imperfections in Crystals; (4) Carrier Concentrations in Thermal Equilibrium; (5) Electron Transport Phenomena; (6) Thermal Effects in Semiconductors; (7) Optical and High-Frequency Effects in Semiconductors; (8) Diffusion of Electrons and Positive Holes; (9) Methods of Determining the Characteristic Properties of Semiconductors; (10) The Element Semiconductors; (11) Compound Semiconductors; (12) Some Applications of Semiconductors. The last three chapters deal with the practical aspects of the subject and the rest of the material is a theoretical approach to various properties of semiconductors.

The book will appeal mainly to physicists who are aspirants in the field of solid state physics. Those engineers, who have a leaning to physics, will find the basic physical concepts explained in a lucid style. Numerous references are given in the body of the book.

A. J.

**An Introduction to the Chemistry of Heterocyclic Compounds.** By R. M. Acheson. (Interscience Publishers, New York, N.Y.), 1960. Pp. xiv + 342. Price \$15.00.

Heterocyclic chemistry necessarily occupies a minor place in general text-books of organic chemistry, although the importance of the subject is recognized by the publication of numerous books, including the Elderfield and Weissberger series, dealing in great detail with

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specific heterocyclic systems. The object of this slim volume, which it fulfils very successfully, is to present a concise account of the physical properties and chemical reactions of heterocyclic systems. Bond lengths and bond angles from microwave spectra are given wherever available, together with  $\pi$ -electron densities obtained by molecular orbital calculations, infra-red data and  $pK_a$  values. Chemical properties are discussed in the light of modern electronic and mechanistic concepts. The treatment of each heterocyclic type includes brief accounts of natural occurrence, synthetic methods, and compounds of special interest such as chemotherapy; the metabolism and biosynthesis of some important compounds are also discussed. Alkaloids and dyes in general are excluded; exceptions are tartrazine, indigo, thioindigo and some cyanine dyes. So recent a discovery as 6-aminopenicillanic acid is included. An obsolete method is cited for the synthesis of quercetin, and quercetin 5, 7, 3', 4'-tetramethyl ether cannot be prepared by boiling the pentamethyl ether with hydrochloric acid. The reference to Birch in p. 255 does him an injustice, ignoring his later publications (cf. his Chapter, p. 206, in Zechmeister, *Progress in the Chemistry of Organic Natural Products*, Vol. 14, 1957). There are other (perhaps inevitable) inaccurate or obscure statements, but the contents of the book as a whole are authentic and up-to-date, considering the limited space in which a vast and complex field is covered.

Beginning with heterocyclic analogues of cyclopropane, nine chapters deal systematically with 4, 5 and 6-membered rings containing N, O and S, fused ring systems, and compounds containing more than one hetero-atom in a ring. Each chapter is accompanied by a general bibliography and adequate references to the original literature. Reference 47 in p. 256 is missing.

At the M.Sc. level the book will prove to be useful as a supplement to single-volume textbooks of organic chemistry and as an introduction to advanced treatises on individual heterocyclic types, alkaloids and other natural products.

K. V.

**Quantum Chemistry: Methods and Applications.**

By R. Dandel, R. Lefebvre, and C. Moser. (Interscience Publishers, Inc., New York), 1959. Pp. 579. Price \$14.50.

Application of wave-mechanics to problems in chemistry has led to a deeper understanding of chemical binding and chemical reactivity. This branch which is really theoretical chemistry

came to be recognised as a distinct field under the title "Quantum chemistry". The well-known book in this field is the one by Eyring, Walter and Kimball and there are several other books dealing with various aspects of quantum chemistry, each having its own merit. It should however be remarked that the subject is necessarily bound up with a lot of mathematical formalism, familiarity with which is a prerequisite for grasping the foundations of the subject. If the book is aimed at selling the subject to the chemists in general, the presentation of matter should be clothed in chemical language and the various methods and approximation be introduced in simple steps, avoiding a rigorous mathematical approach.

The book under review has this merit and sets out the methods of calculation of wave functions and how to use these to study some physical and chemical properties. The book is divided into two parts of which Part I is an exposition of simple methods and their application. After a brief introduction to quantum chemistry and principles of wave-mechanics in the earlier sections, the various approximations and simple methods are set out. Theoretical study of interatomic distances, calculation of angles, bond dissociation resonance and ionization energies, absorption spectra in the visible and ultra-violet regions, electronic density and dipole moment are treated in the succeeding six sections. In the next three sections, chemical reactivity and biochemical applications are given. In Part II are set out some rigorous treatments and more elaborate approximations. An extended discussion is given of the fundamental principles of quantum mechanics with brief statements on operators, variation and perturbation theory, angular momentum, spin and spatial symmetry. There are three appendices which deal respectively with Expansion and Resolution of Secular Equations, Self-consistent Field Equations and The Calculation of Atomic Integrals.

The reviewer is of the opinion that the book would be of interest to the theoretical chemists, particularly the theoretical organic chemists and to all those who have taken to chemical physics.

A. J.

**Nucleoproteins: Solvay International Institute of Chemistry Conference.** Editor: R. Stoops. (Interscience Publishers, Inc., New York), 1959. Pp. 364. Price \$10.50.

The volume gives an account of the proceedings of the symposium on the physico-chemical, chemical and biological aspects of desoxy and



ribonucleic acids and their associated proteins derived from different biological sources. There are in all, ten articles together with a verbatim account of the proceedings. The concluding chapter deals with a general discussion of the whole subject by the various participants of this Conference.

In the first article, J. Brachet has discussed the role of desoxyribonucleic acid (DNA) in the transmission of hereditary characters and of ribonucleic acid (RNA) in protein synthesis. M.H.F. Wilkins has presented considerable X-ray data, supplemented with results obtained by use of the electron microscope for the elucidation of the structural relationship of the DNA molecule and the associated nucleohistone and protamine. By indirect evidence, he has deduced that the DNA of chromosomes is highly coiled and its structure is different from the uncoiled nucleohistone-protamine complex, largely found in the sperm. The suggestion has also been made that the histone exists only for structural purposes in chromosomes and may probably be involved in the mechanism of gene action.

S. Moore has presented a paper on an improved procedure for the isolation of histone from nucleoproteins in a form probably closer structurally to the 'native' cellular protein. The nucleohistones presented in calf thymus and rich in lysine and arginine respectively have been separated. The problem of specificity of combination between DNA and histone has been investigated and evidence for *in vivo* specificity has been presented, for the first time.

A. Rich, Sir Alexander Todd and S. Ochoa have discussed in separate papers, physico-chemical properties of polynucleotides and their chemical and biosynthetic mechanisms, while C. Sadron and J. A. V. Butler in their respective articles describe the physico-chemical properties of DNA in solution, the heterogeneous nature of the same and the effects of physical and chemical agents on the lability of the DNA molecule. Further, the labile nature of the hydrogen bond, in this macromolecule, has also been emphasised.

Information on the nature of nucleic acid associated with bacteria, algae and higher plants as also with tobacco mosaic virus has been given by A. N. Belozersky as well as by G. Schramm in their contributions to this Conference.

It is pleasing to note that recent research work, which has revolutionised our views on the biological role of nucleoproteins has been very well presented in this symposium. In addition, the physico-chemical properties of nucleoproteins have also been fully described.

The volume will be a useful addition to the biochemist's bookshelf, and is indispensable to workers in the field of nucleoproteins.

P. S. SARMA.

**University Physics.** By F. C. Champion. (Blackie & Son Ltd., London W.C. 2; India: 103-5, Fort Street, Bombay), 1960. Pp. 786. Price 30 sh..

Prof. F. C. Champion's five books in the series, University Physics, are well known to undergraduate and graduate students of Indian Universities. These five popular and handy publications have been now issued for the first time in one volume of about 800 pages in excellent print and paper, free from mistakes. Exercises are given at the end of each chapter, and numerical examples with answers and hints for solution at the end of each part.

The book is primarily intended for the First Year University students, but will be generally useful for the B.Sc. students also and for those in other disciplines for whom Physics is a subsidiary subject.

A. S. G.

**Zygnemaceae.** By M. S. Randhawa. (Indian Council of Agricultural Research, New Delhi), 1959. Pp. 478. Price Rs. 26-00 or 50 sh.

This monograph on Zygnemaceae by Dr. M. S. Randhawa is the first of the series on Indian Algae which the Indian Council of Agricultural Research has undertaken on its publication programme. These publications are bound to fulfil a long-felt need of workers on Algae in India. The monograph under review is a valuable compendium of the nearly 580 species of Zygnemaceae so far recorded from all over the world. The number of species of the genera reported from different countries is given in Table I on pp. 34-35, from which it will be gathered that the largest number is from North America and the second largest from China and India respectively. It thus shows the interest of Indian workers on this group of Algae. It is in the form of a flora with keys for the determination of genera and species. The illustrations are clear and copious, and contribute much to the general usefulness of the work.

The cytological data given in Chapter 4 of the monograph are inadequate. There is no mention of the outstanding contributions of Godward on the nucleolus, nucleolar organizing chromosomes, diffuse centromere, and cytotaxonomy of *Spirogyra*. The chromosome numbers

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given on p. 59 are incomplete (cf. Tischler, G., *Handb. Pflanz. zenanotomie*, Band II, Allgemeine Pflanzenkaryologie, Berlin, 1951). References on pp. 101-102 are overlapping those at the end.

R. N. SINGH.

**Cyanophyta.** By T. V. Desikachary. (Indian Council of Agricultural Research, New Delhi), 1959. Pp. 686. Price Rs. 37-00 or 72 sh.

Blue-green Algae have been intensively studied in some parts of India for the last quarter of a century or so, and the rich and diverse character of this flora has been suitably epitomized in Desikachary's monograph, the second in the series of Algal Studies which the Indian Council of Agricultural Research has undertaken on its publication programme. The author has divided this monograph into two parts. Part I is devoted to a description of general morphology, limnological aspects, etc. This part has been dealt with rather inadequately and incompletely in the light of some recent results. It is however, in Part II, which takes the form of a flora with keys for the determination of genera and species and diagnoses and figures of the nearly 750 species so far recorded from India and its neighbourhood that the monograph is most valuable. It thus constitutes a compilation that is of considerable value and will serve as a stimulus to those continuing with the task of exploration of the vast unexplored land. References to standard taxonomic works and habitat data are given for most species which may be useful to workers outside India.

The copious and for the most part clear illustrations contribute much to the general usefulness of the monograph. A proportion of the figures are original although some of them are of a somewhat diagrammatic type.

R. N. SINGH.

**Antibiotics in Medicine—British Medical Bulletin**, Vol. 16, No. 1. (The Medical Department, The British Council, London), January 1960. Pp. 1-88. Price 20 sh.

Though, the structure of individual antibiotics differ widely, they have several biological properties in common. They appear to arise from variations on a limited number of biogenetic themes. They have been classified in a manner designed to illustrate the structural and biogenetic relationships between them. Three broad divisions, antibiotics derivable from amino-acids or similar units, those mainly or

partly from acetate, and those from sugars stand out clearly while a miscellaneous heterogeneous group cover the rest.

The nature of the selective toxicity of antibiotics, as exemplified by the action of penicillin on cell wall synthesis, of surface-active antibiotics on membrane permeability and of chloramphenicol on protein synthesis promises to throw light on the basic biochemistry of life besides giving lead to the synthesis of newer chemotherapeutic compounds.

The highly controversial topic of the "mechanism of drug-resistance and the emergence of drug-resistant population", deals with enzyme induction, genic alterations, heritability of drug-resistance and the applications of these findings to the control of the emergence of drug-resistance organisms.

"Preventive use of antibiotics in medicine and surgery", "the principles of therapeutic use" and the 'combined therapy' review the hazards, limitations and the utility of antibiotics in clinical practice. The mounting problem of antibiotic resistance in clinical practice, the dangers of antibiotic treatment and the present therapeutic status of antibiotics in bacterial endocarditis and tuberculosis are other chapters of interest to clinicians. The articles on "The pharmacology of the antibiotics", "The techniques likely to be helpful for rapid laboratory control of antibiotic therapy", and the note on the "laboratory uses of antibiotics in contrast to their therapeutic uses", and "The search for new antibiotics" discuss critically many aspects of this rapidly developing branch of chemotherapy.

The monograph has justified its aim of 'providing the reader with well-ascertained information on which he can base his own opinion'.

M. SIRSI.

**Cotton in India.** By B. L. Sethi, S. M. Sikka, K. H. Dastur, P. D. Gadkari, R. Balasubramanyam, P. Maheshwari, N. S. Rangaswamy and A. B. Joshi. (Indian Central Cotton Committee, 14 Nicol Road, Ballard Estate, Bombay-1), 1960. Pp. xiv + 474. Price Rs. 30-00.

The importance of cotton and its role in the economy of our country needs hardly any special mention. The Indian Central Cotton Committee by publishing this monograph on cotton has removed the lacuna which was being felt by the research workers, teachers and others connected with the industry for want of a good reference book on cotton embodying the results

of researches carried out so far in India and abroad. This is the first volume of the Monograph in the series, comprising of eight chapters dealing with History of Cotton; Climate and Soils; Taxonomy; Morphology; Embryology; Breeding; Cytology and Genetics respectively. The contributions to several chapters have been made by eminent men in the field and are quite exhaustive. The chapter on classification of the genus *Gossypium* is very helpful as many of the existing doubts have now been cleared. The description of the plant, morphological, anatomical and Embryology detailed in Chapters IV and V is particularly useful to all the students of Botany—Pure Science or Agricultural. The last three chapters on Breeding, Cytology and Genetics not only deal with the methods of evolution of some of the well known and established varieties of cotton but also give fundamental information for the research workers in the field of Cytogenetics and Plant Breeding. The contributors to these Chapters have taken particular pains to collect valuable information even from some of the unpublished records and Departmental reports. The information regarding the suitability and characteristic features of the several varieties is of great practical significance. The references quoted at the end of each Chapter are an asset.

The Monograph is eminently suited as a standard Text-Book for all students of agriculture and a valuable reference book for the teachers and research workers.

B. VENKOBÄ RAO.

**The Distribution of Pelagic Polychaetes in the South Atlantic Ocean.** By Norman Tebble. (*Discovery Reports*, Vol. XXX). (Cambridge University Press), 1960. Pp. 161-300. Price £. 3-6-0.

This volume is a welcome addition to the series of contributions to our knowledge of plankton of the Southern Seas, based on the collections made by the R.R.S. *Discovery*, *Discovery II* and *William Scoresby*, which have appeared in the earlier volumes of the *Discovery Reports* issued by the Discovery Committee and later by the National Institute of Oceanography, and is in a line with the outstanding contributions of Hardy, Hardy and Gunther, Hart, Mackintosh, Munro and Kramp; to mention a few. The present account deals with the Pelagic Polychaetes of the South Atlantic Ocean (which are of considerable importance in the cycle of life in the sea) with reference

to their environment, worked out by Norman Tebble of the British Museum (Natural History).

After a short introduction, the author gives particulars relating to the material and methods employed. In the two appendices, the species collected are listed station-wise; this together with the several charts help one to understand the distribution of the polychaete fauna dealt with.

The subject-matter proper of the account is divided into two main sections: (i) Systematic Account and (ii) Zoo-geography. Under the latter, the Hydrological Environment and Distribution of Species are discussed separately. A succinct review and a very useful list of references incorporating most of the relevant literature on polychaetes are furnished at the end.

In the systematic section, the author has described in detail 29 species with their synonyms. The author has created a new combination, viz., *Rhynchonerella bongraini* (Gravier) Tebble, to include *Callizona bongraini* of Gravier; *Callizonella bongraini* of Augener, Fauvel and Munro; *Rhynchonerella fulgens* of Munro, and *Krohnia bongraini* of Stop-Bowitz.

The account on hydrology could have been considerably condensed as most of the data contained therein are drawn from earlier publications dealing with the same region and published in the *Discovery Reports*.

The distribution of 24 species of polychaetes is discussed in detail with the help of charts and tables. The pattern of distribution conforms to that of other planktons, viz., a few species occurring in large numbers making up an abundant crop in the upper 150 m. of water in the Antarctic zone, while a variety of species constitute the bulk in the sub-tropical and tropical zones. Thus, the cosmopolitan species *Pelagobia longicirrata* occurs in large numbers in the Antarctic zone; *Rhynchonerella bongraini*, endemic to the Antarctic, occurs in abundance but restricted in distribution. Of nine other species of the Antarctic zone which do not occur in large numbers, seven are cosmopolitan or widely distributed. The distribution of 16 species is limited by the sub-tropical convergence; none of them occur in abundance. *Tomopteris septentrionalis* and *T. planktonis* which are cosmopolitan have been netted in large numbers in the sub-tropical zone off South Africa in a region of intensive activity of the expeditions.

It is not possible in a review of this nature to go into fuller details. The publication concerned contains a wealth of information to

planktologists in general and workers on poly-  
chaetes in particular and must find a place in  
all libraries.

R. SUBRAHMANYAN.

# Books Received

*Royal Society Mathematical Tables* (No. 6)—  
*Tables of Riemann Zeta Function*. By C. B.  
Haselgrove and J. C. P. Miller; (No. 7),  
Part III—*Bessel Functions Zero and Associated  
Values*. Edited by P. W. J. Oliver. (Cam-  
bridge University Press, London N.W. 1),  
1960. Pp. xxii + 80. Pp. lx + 79. Price  
50 sh. each.

*American Journal of Science*—The Bradley  
Volume. Edited by John Rodgers, Joseph T.  
Gregory. (American Journal of Science,  
Sterling Tower, New Haven, Conn.), 1960.  
Pp. vii + 433. Price \$ 8.50.

*Reactor Hand Book* (Vol. I)—Materials. Edited  
by C. R. Tipton. (Interscience Pub., New  
York), 1960. Pp. xv + 1,207. Price \$ 36.50.

*Advances in Space Science* (Vol. 2). Edited by  
F. I. Ordway, III. (Academic Press, New  
York-3), 1960. Pp. xiii + 450. Price \$ 13.00.

*The Chemistry and Biology of Sialic Acids and  
Related Substances*. By A. Gottschalk. (Cam-  
bridge University Press, London N.W. 1),  
1960. Pp. ix + 115. Price 22 sh. 6 d.

*Statistical Thermodynamics*. (Paper Edition).  
By Erwin Schrodinger. (Cambridge University  
Press, London N.W. 1), 1960. Pp. 95. Price  
8 sh. 6 d.

*Extractive and Physical Metallurgy of Plutonium  
and its Alloys*. Edited by W. D. Wilkinson.  
(Interscience Pub., New York-1), 1960.  
Pp. x + 314. Price \$ 10.50.

*The World of Physics*. By Arthur Beiser.  
(McGraw-Hill Book Co., New York), 1960.  
Pp. x + 286.

*Plant Physiology a Treatise* (Vol. 1)—Cellular  
Organisation and Respiration. Edited by F. C.  
Steward. (Academic Press, New York;  
India: Asia Pub. House, Bombay-1), 1960.  
Pp. xxvii + 331. Price \$ 13.00.

*Dynamics* (Paper Edition). By Horace Lamb.  
(Cambridge University Press, London N.W. 1),  
1960. Pp. xi + 351. Price 18 sh. 6 d.

*Biological and Chemical Control of Plant and  
Animal Pests*. Edited by L. P. Reitz. (Ameri-  
can Association for the Advancement of  
Science, 1515 Mass Ave., N.W. Washington  
5 D.C.), 1960. Pp. 285. Price \$ 5.75.

*From Dualism to Unity in Quantum Physics*.  
By Alfred Lande. (Cambridge University  
Press, London N.W. 1), 1960. Pp. xvi + 114.  
Price 18 sh. 6 d.

*Advances in Organic Chemistry* (Vol. II)—  
Methods and Results. Edited by Ralph A.  
Raphael, Edward C. Taylor and Hans Wynberg.  
(Interscience Pub., New York), 1960. Pp.  
vii + 504. Price \$ 15.00.

*An Introduction to Stochastic Processes*. By  
M. S. Bartlett. (Cambridge University Press,  
London N.W. 1), 1960. Pp. xiv + 312. Price  
22 sh. 6 d.

*Insulin*—British Medical Bulletin, Vol. 16, No. 3,  
September 1960. (The Medical Department,  
The British Council, 65 Davies Street,  
London W. 1). Pp. 175-264. Price 20 sh.

*Mechanics* (2nd Edition). By K. R. Symon.  
(Addison-Wesley Pub. Co., Reading, Mass.,  
U.S.A.), 1960. Pp. xiv + 557. Price \$ 8.00.

*Röntgenstrahl—Interferenzen*. By Max Von  
Laue. (Akademische, Verlagsgesellschaft,  
M.B.H., Frankfurt Am Main Sud, Holbein-  
strasse 25-27), 1960. Pp. x + 476. DM 75.

*Crystal Structures* (Supplement V). By Ralph  
W. G. Wyckoff. (Interscience Pub., New  
York), 1960. Price \$ 26.50.

*International Review of Neurobiology*. Edited  
by Carl C. Pfeiffer, John R. Smythies. (Aca-  
demic Press, New York), 1960. Pp. xii + 410.  
Price 80 sh.

*Fortschritte Der Hochfrequenztechnik*. By J.  
Zenneck, M. Strutt, F. Vilbig. (Akademische,  
Verlagsgesellschaft, M.B.H., Frankfurt, Am  
Main Sud, Holbeinstrasse 25-27), 1959. Pp.  
xiii + 321. Price DM 42.

*Getriebelehre I—Geometrische Grundlagen*. By  
P. Grodzinski, G. Lechner. (Walter De  
Gruyter, Berlin W. 35, Genthinerstrabe 13),  
1960. Pp. 164.

*Advances in Enzymology* (Vol. 22). Edited by  
F. F. Nord. (Interscience Pub., New York),  
1960. Pp. v + 567. Price \$ 14.00.

*Proceedings of the Symposium on the Chemistry  
of Co-ordination Compounds—in three parts*,  
Part I: Pp. 148 + iii. Price Rs. 15-00;  
Part II. Pp. 203 + ii. Rs. 25-00; Part III:  
Pp. 302 + x. Rs. 35-00. (National Academy  
of Sciences, India, Lalpatrai Road, Allahabad).

*Foundations of Modern Analysis*. By J. Dieu-  
donne. (Academic Press, New York), 1960.  
Pp. xiv + 361. Price \$ 8.50.

*An Introduction to Homological Algebra*. By  
D. G. Northcott. (Cambridge University  
Press, London N.W. 1), 1960. Pp. xi + 282.  
Price 42 sh. 6 d.

*Water and Agriculture*. Edited by Roy D.  
Hockensmith. (American Association for the  
Advancement of Science, 1515 Mass Ave.,  
Washington 5 D.C.), 1960. Pp. 206. Price  
\$ 5.00.

## SCIENCE NOTES AND NEWS

## The Prospects of Flint X Dent Hybrids in Maize

Sri. S. Vittal Rao, Regional Maize Breeding Station, Hyderabad-13, writes:—

The flint variety forms the bulk of the maize crop in India. The existing varieties being low yielders, the yields of maize could be easily doubled by the use of suitable hybrids. Though the American Dent hybrids have given 80-120% more yields than the local flints, dent type of grain is not favoured by the Indian farmer (see *Curr. Sci.*, 1960, 29, 295). Thus in India we have large scope in developing suitable flint × dent hybrids possessing the desired hardness of grain. Among the many flint × dent hybrids synthesized at the Regional Maize Breeding Station, Hyderabad (WF 9 × 38-11) (KL 1 × KL 3) has given consistently superior yields over the best U.S.A. hybrid, Texas 26 by a margin of 5-8% besides possessing the required grain character. (WF 9 × 38-11) is a dent single cross from U.S.A. and (KL 1 × KL 3) is a flint single cross of local origin. Efforts are also being intensified to utilise the germplasm of some of the regions of South America where flint type of grain is preferred and also being grown as human food.

## Award of Research Degree

Andhra University has awarded the D.Sc. Degree in Physics to Messrs. R. Raghava Rao and B. Lakshminarayana for their theses entitled "Studies on the Horizontal Drifts in the 'E' Region at Waltair" and "Experimental Investigations on Dielectric Dispersion of Certain Polar Liquids" respectively.

Osmania University has awarded the Ph.D. Degree in Botany, to Shri L. Lakshminarayana for his thesis entitled "Studies on the Floral Anatomy and Embryology of Some Geraniales".

## International Termite Symposium

An International Symposium on Termites in the Humid Tropics was held in New Delhi from 4th-12th October, 1960, under the joint auspices of the Zoological Survey of India and UNESCO, and presided over by Dr. M. L. Roonwal, Director of the Zoological Survey of India. Sixty delegates from nine different countries, viz., Burma, Ceylon, India, Indonesia, Pakistan, U.K., U.S.A., USSR and West Germany, attended.

Forty papers were presented and discussed in the six sections: (1) Systematics and Morphology (Chairman: Prof. A. E. Emerson of Chicago). (2) Physiology and Development (Chairman: Dr. J. N. Misra of Kanpur). (3) General Biology (Chairman: Dr. W. V. Harris of London). (4) Ecology (Chairman: Prof. M. S. Ghilarov of Moscow). (5) Intestinal Cellulose-digesting Symbionts (Chairman: Dr. J. N. Misra of Kanpur). (6) Termite Control and Termite-proof constructions (Chairman: K. Gosswald of Wurzburg).

A Termite Exhibition was also held as a part of the Symposium. Among the more interesting exhibits were the soldiers which have recently been discovered in India in the genus *Speculitermes* (hitherto regarded as devoid of the soldier caste), nests of the genus *Apicotermes* and techniques for breeding fungus-growing termites in the laboratory. A day's excursion to the forests of Dehra Dun was also organized.

The Proceedings of the Symposium will be published in full by the UNESCO.

## UNESCO Training Course on Soil Salinity and Symposium on Plant Resources

A Regional Training Course on Soil Salinity, organised jointly by the Government of Pakistan and the UNESCO South Asia Science Co-operation Office, will be held at the WAPDA, Directorate of Land Reclamation, Lahore (West Pakistan) from November 30 to December 17, 1960. It has been planned in close connection with the Pakistan National UNESCO Commission.

The training course is expected to bring together 25 participants from Afghanistan, Burma, Ceylon, India, Nepal and Pakistan.

The UNESCO experts, Dr. Roy L. Branson, Extension Soils and Water Specialist, University of California, and Prof. J. Boulaine, Professor of Pedology, University of Alger will conduct the training course. The course will include, among other topics, the formation and occurrence, the physical and chemical properties of saline and sodic soils, tolerance of crops to salinity, quality of irrigation waters and classification and mapping of saline soils.

The international symposium on Plant Resources of the Middle East and South Asia for the Pharmaceutical industry and Rauwolfia,



organized jointly by the Government of Pakistan, the UNESCO Middle East Science Co-operation Office, and the UNESCO South Asia Science Co-operation Office, will be held at the North Regional Laboratories of the Pakistan Council of Scientific and Industrial Research, Peshawar (Pakistan), December 6-14, 1960. The symposium will bring together leading specialists in different fields related to medicinal plants (botanical, chemical, and pharmacological) from the Middle East and South Asia.

Further information concerning the Training Course and the Symposium can be obtained from the UNESCO South Asia Science Co-operation Office, 21, Curzon Road, New Delhi, or the Indian National Commission for UNESCO, Ministry of Education, Government of India, New Delhi.

#### Microporous Plastic

A new, porous plastic—nearly 80% air—manufactured by a large concern in Pennsylvania seems to be in for a bright future. The microporosity of the plastic is the key to its future. The plastic contains millions of holes too tiny to be seen by the naked eye. The holes are actually so small that water will not pass through them but steam, or vapour will.

The process for making the microporous plastic is a relatively simple one. A mixture of common starch and a non-porous plastic is added to boiling water. As the starch swells, forming tiny cellular bubbles, the plastic swells along with it, incorporating the tiny bubbles. The starch is then dissolved with acid and the new porous plastic shrinks back to its original size. Besides its use in the manufacture of bandages, filters and specialized hospital goods, the microporous plastic will find application in water purification equipment.—*American Chemical Society*.

#### Tape-Recorder with 40 Hours Continuous Reproduction

A special tape-recorder which can provide forty hours continuous reproduction has been made in Britain. Called the Paraphone, the tape holds forty different sound-tracks side by side, running alternately in opposite directions, and the sound pick-up has two heads. For continuous running the machine winds the spool first one way, then the other. At the end of each run-through a photo-electric cell operates a mechanism which reverses the spool and moves the pick-up head on to the sound-track. After the first twenty runs the second pick-up head

takes over from the first to complete the full course. The machine is no bigger than the average domestic tape-recorder—it weighs 40 lb. and measures 14 inches square by 12 inches deep.—*I.S.L.O. News Letter*.

#### National Institute of Sciences

At the Annual General Meeting of the Institute held on October 7, 1960, Dr. Atma Ram, Director, Central Glass & Ceramic Research Institute, Calcutta, was awarded the Shanti Swarup Bhatnagar Gold Medal 1959, and Sri. Hiralal Chaudhuri, Research Officer (Fish Breeding), Central Inland Fisheries Research Station, Barrackpore, the Chandra Kala Hora Memorial Medal 1960.

#### Decay Scheme of $Tl^{210}$ (RaC')

The decay of  $Tl^{210}$ , although studied since the beginning of this century, is still not known with sufficient accuracy. Especially, the number and energies of gamma-rays are not certain. A careful investigation of the decay scheme of  $Tl^{210}$  is being carried out by The First Physical Institute, of the Vienna University, Austria, along the following lines:

- Further improvement of the purity of  $Tl^{210}$  sources. Experience has shown that this depends to a large extent on the purity of Rn used to obtain the active deposit. A new apparatus for the Rn purification has been constructed.
- Measurements of delayed ( $\beta$ ,  $\gamma$ ) and ( $\gamma$ ,  $\gamma$ ) coincidence using a fast slow coincidence arrangement and a multi-channel analyser.
- Depending on the results of the lifetime measurements, eventually correlation between the principal  $\gamma$ -rays in the decay will be made.
- Measurement of the neutrons emitted from the source, exact comparison of the half-life of this neutron activity with the  $Tl^{210}$  half life and determination of the neutron energy.
- Measurement of the precise energies of the principal  $\gamma$ -rays in the  $Tl^{210}$ -decay by means of a permanent magnet  $\beta$ -spectrograph with photographic recording. Estimates of conversion coefficients.
- Theoretical calculations based on the shell model and comparison with experimental results.—*Special news letter*, I.A.E.A.



### Simple Device for Viewing X-Ray Precession Photographs in Three Dimensions

The understanding of the reciprocal lattice in X-ray crystallography is fundamental to the interpretation of the precession photography taken with a Buerger precession camera. The undistorted X-ray diffraction photograph obtained with such a camera from an appropriately oriented single crystal shows the reciprocal lattice in two dimensions. E.C.T. Chao has described (*Amer. Mineralogist*, 1960, 45, 890) a device that can easily be built up to show the photographed reciprocal lattice of the crystal in three dimensions.

It consists of a box made of  $\frac{1}{4}$ " clear plastic material such as lucite. The side plates are "dadoed" or slotted and held together by screws to a top and a bottom plate. The precession films are inserted along the slots and are held in place one on top of the other. The slots are spaced 1 mm. apart to allow the films to be placed at the approximately correct heights.

A stereoscopic pair of photographs is taken of superimposed films in this device and when viewed with a pocket stereoscope, illustrates the clarity with which the oblique reciprocal cell can be visualized. With the three dimensional view of the reciprocal lattice in front of one, the indexing of the reflections is simplified and systematic extinctions of reflections readily observed.

The following dimensional details will help one to construct the device: width of cut slots  $1/64$ " or 0.4 mm.; depth of slots  $1/16$ " or 1.6 mm.; spacing of slots  $1/25$ " or 1 mm.; width between side plates  $5\frac{1}{8}$ " or 124 mm. over all outside dimensions  $5 \times 6\frac{1}{2} \times 1\frac{1}{2}$  inches.

### Production of Tritium in Nuclear Fission

In nuclear fission although ejection of alpha particles (approximately one particle for each 300 fissions) has been well established, the production of triton (tritium nucleus) has not been observed before. For the first time this observation has been reported from the Savannah River Reactor Centre. Eight samples of natural uranium, irradiated over an exposure of 300-1,600 Mwd./ton, gave a fission-to-tritium ratio

of  $1.05 \pm 0.09 \times 10^4$ . The samples on which these results were based were derived from experimental rods of uranium irradiated in a heavy-water-moderated and -cooled Savannah River production reactor. Exposure of the experimental assembly was calculated from measurement of coolant flow, temperature and flux.

Samples were sectioned from each rod, dissolved and analysed for tritium content. Sections weighing 40-80 gm. were cut from each rod, and any adherent film of tritiated deuterium oxide removed with a solution of sodium hydroxide. The uranium of each section was then dissolved in nitric acid in an apparatus designed to collect the off-gas quantitatively. The collected gas was scrubbed to remove nitrogen oxides and then was passed through a copper oxide combustion tube to convert any hydrogen to water. Tritium was measured by liquid scintillation counting. About 25% of the total tritium was found in the gas phase.—*Nucleonics*, September 1960.

### Biogeochemical Prospecting

Plants growing on the earth's surface can help prospectors to determine what minerals are to be found deep down in the earth at that particular spot. The chemical composition of the plants growing on the surface of proved ore deposits has been studied and a list drawn up of the grasses, shrubs and trees which show specific preference for certain metals. It has been established that the indigenous varieties of maize (which are different to the European ones) serve as indicators of silver and not gold. So also do wormwood and thistle growing on the surface of ore deposits actively accumulate tin and gold in their tissues.

Deposits of copper, nickel, gold and silver have been discovered by means of this method in the foothills of the Naura Tau range in Central Asia. Practical use of the indicator plants is now being made in prospecting conducted in the deserts, semi-deserts and mountainous areas of Central Asia. This method is known as biogeochemical prospecting.—*Soviet Radio News*.

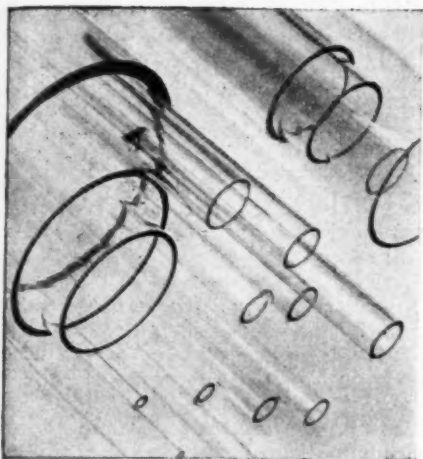
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Curr. Sci., November 1960

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**DELHI:** The whole of Delhi.

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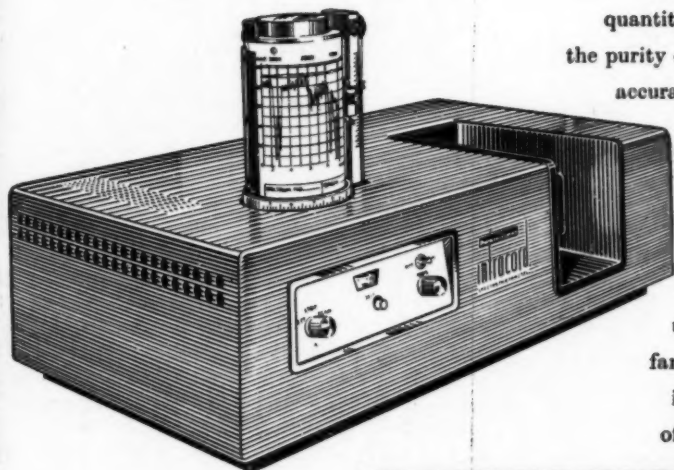
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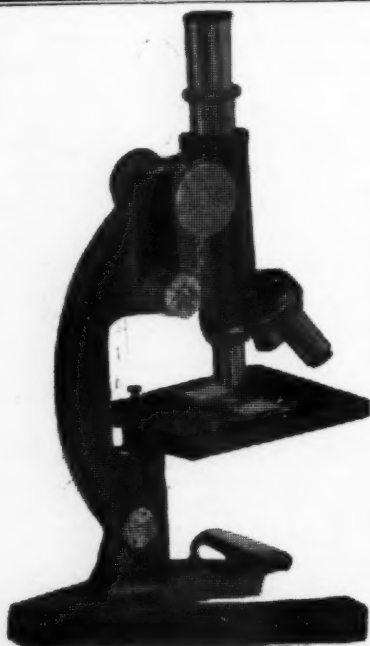
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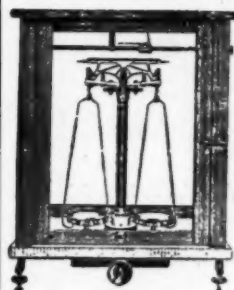
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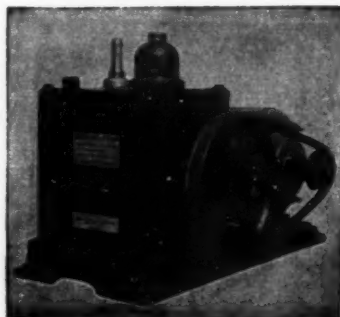
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